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U. S. DEPARTMENT OF AGRICULTURE

WEATHER BUREAU

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MONTHLY WEATHER REVIEW

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NOVEMBER, 1917

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NOVEMBER, 1917.

CONTENTS.

NOTICE TO CONTRIBUTORS.

Contributions intended for publication in any given issue of the MONTHLY WEATHER REVIEW (e. g., January) should be in the hands of the editor before the end of the next following month (e. g., February), if no illustrations are required. When the paper is illustrated, the manuscript and the copy for illustrations must be submitted much earlier, in order to permit copy being prepared for the engraver by the end of the month.

REPRINTS are made up without covers in the original size and pagination of the REVIEW. They will not be furnished unless specifically REQUESTED WHEN THE MANUSCRIPT IS SUBMITTED.

MONTHLY WEATHER REVIEW

CLEVELAND ABBE, jr., Editor.

VOL. 45, No. 11.
W. B. No. 632.

NOVEMBER, 1917.

CLOSED JAN. 3, 1918
ISSUED JAN. 31, 1918

INTRODUCTION.

As explained in this Introduction during 1914, the MONTHLY WEATHER REVIEW now takes the place of the Bulletin of the Mount Weather Observatory and of the voluminous publication of the climatological service of the Weather Bureau. The MONTHLY WEATHER REVIEW contains contributions from the research staff of the Weather Bureau and also special contributions of a general character in any branch of meteorology and climatology.

SUPPLEMENTS TO THE MONTHLY WEATHER REVIEW are published from time to time.

The climatological service of the Weather Bureau is maintained in all its essential features, but its publications, so far as they relate to purely local conditions, are incorporated in the monthly reports "Climatological Data" for the respective States, Territories, and colonies.

Beginning August, 1915, the material for the MONTHLY WEATHER REVIEW has been prepared and classified in accordance with the following sections:

SECTION 1.—*Aerology.*—Data and discussions relative to the free atmosphere.

SECTION 2.—*General meteorology.*—Special contributions by any competent student bearing on any branch of meteorology and climatology, theoretical or otherwise.

SECTION 3.—*Forecasts and general conditions of the atmosphere.*

SECTION 4.—*Rivers and floods.*

SECTION 5.—*Seismology.*—Results of observations by Weather Bureau observers and others as reported to the Washington office.

SECTION 6.—*Bibliography.*—Recent additions to the Weather Bureau library; recent papers bearing on meteorology.

SECTION 7.—*Weather of the month.*—Summary of local weather conditions; climatological data from regular Weather Bureau stations; tables of accumulated and excessive precipitation; data furnished by the Canadian Meteorological Service; monthly charts Nos. 1, 2, 3, 4, 5, 6, 7, 8, the same as hitherto; Meteorological Summary and chart No. 9 of the North Atlantic Ocean for this month in 1916. Owing to the fact that ocean meteorological data are frequently not available for a considerable time after the close of the month to which they relate, the chart and text matter in connection therewith appear one year late.

In general, appropriate officials prepare the seven sections above enumerated; but *all students of atmospherics are cordially invited to contribute such additional articles as seem to be of value.*

The voluminous tables of data and text relative to local climatological conditions, that during recent years were prepared by the 12 respective "district editors," are omitted from the MONTHLY WEATHER REVIEW, but are collected and published by States at selected section centers. (See Cover, p. 3.)

The data needed in Section 7 can only be collected and prepared several weeks after the close of the month designated on the title-page; hence the REVIEW as a whole can only issue from the press within about eight weeks from the end of that month.

It is hoped that the meteorological data hitherto contributed by numerous independent services will continue as in the past. Our thanks are specially due to the directors and superintendents of the following:

The Meteorological Service of the Dominion of Canada.
The Meteorological Service of Cuba.
The Meteorological Observatory of Belén College, Habana.
The Government Meteorological Office of Jamaica.
The Meteorological Service of the Azores.
The Meteorological Office, London.
The Danish Meteorological Institute.
The Physical Central Observatory, Petrograd.
The Philippine Weather Bureau.

The Weather Bureau desires that the MONTHLY WEATHER REVIEW shall be a medium of publication for contributions within its field, but such publication is not to be construed as official approval of the views expressed.

SECTION I.—AEROLOGY.

SOLAR AND SKY RADIATION MEASUREMENTS DURING NOVEMBER, 1917.

By HERBERT H. KIMBALL, Professor of Meteorology.

[Dated: Washington, D. C., Dec. 31, 1917.]

For a description of instrumental exposures and an account of the methods of obtaining and reducing the measurements the reader is referred to the REVIEW for January, 1917, **45**:2.

The monthly means and departures from normal values given in Table 1 show that direct solar radiation averaged below normal at all four stations.

Table 3 shows only a slight departure from the normal November radiation at Washington and a deficiency of about 11 per cent at Madison, Wis.

Skylight polarization measurements at Washington on 9 days give a mean of 52 per cent, with a maximum of 60 per cent on the 8th. This is considerably below the corresponding averages for November for Washington. At Madison measurements on 7 days give a mean of 60 per cent with a maximum of 71 per cent on the 20th.

TABLE 1.—*Solar radiation intensities during November, 1917.*

[Gram-calories per minute per square centimeter of normal surface.]

Washington, D. C.

Date.	Sun's zenith distance.									
	0.0°	48.3°	60.0°	66.5°	70.7°	73.6°	75.7°	77.4°	78.7°	79.8°
	Air mass.									
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
A. M.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Nov. 1		1.09	0.96	0.85						
2		1.16	1.07	0.99	0.90	0.83	0.76			
3		1.28	1.17	1.07	0.96	0.85	0.73	0.69	0.64	0.60
4			1.32	1.01						
5		1.48	1.36	1.26	1.18	1.10	1.04	0.99	0.94	0.89
6			0.92	0.87						
7			1.29	1.01	0.84		0.72			
8			1.29	1.22						
10			1.03	0.99						
17			0.97	0.78						
26				1.29	1.19					
Monthly means		**1.25**	**1.14**	**1.03**	**1.01**	**0.93**	**0.81**	**(0.84)**	**(0.79)**	**(0.74)**
Departure from 9-year normal		**−0.12**	**−0.04**	**−0.06**	**−0.01**	**+0.02**	**−0.03**	**+0.04**	**+0.04**	**+0.04**
P. M.										
Nov. 3			1.05	0.96	0.89	0.78				
5				1.22	1.15	1.09	1.03	0.97	0.92	0.87
6			0.96							
7			1.21	1.08	1.00	0.96	0.90	0.84	0.79	0.74
10			1.00	0.71	0.63					
12			0.63							
17			1.00	0.90	0.84	0.79	0.71	0.63	0.58	
Monthly means			**0.98**	**0.97**	**0.90**	**0.90**	**0.88**	**0.81**	**0.76**	**(0.80)**
Departure from 9-year normal			**−0.20**	**−0.11**	**−0.07**	**±0.00**	**+0.06**	**+0.04**	**+0.04**	**+0.11**

TABLE 1.—*Solar radiation intensities during November, 1917*—Contd.

Madison, Wis.

Date.	Sun's zenith distance.									
	0.0°	48.3°	60.0°	66.5°	70.7°	73.6°	75.7°	77.4°	78.7°	79.8°
	Air mass.									
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
A. M.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Nov. 3			1.26				0.91	0.83	0.75	0.68
5			1.10	0.96						
16			1.31	1.24	1.21	1.13	1.07	1.01	0.94	
20			1.28	1.18	1.09	1.02	0.95	0.89	0.83	0.81
Monthly means			**1.24**	**1.13**	**(1.15)**	**(1.08)**	**0.98**	**0.91**	**0.84**	**(0.74)**
Departure from 8-year normal			**−0.05**	**−0.07**	**+0.01**	**−0.06**	**−0.04**	**−0.05**	**±0.00**	**−0.03**
P. M.										
Nov. 5				0.96						
16				1.12	0.99					
20				1.19	1.12					
Monthly means				**1.09**	**(1.06)**					
Departure from 8-year normal				**−0.14**	**−0.11**					

Lincoln, Nebr.

Date.	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
A. M.										
Nov. 5			1.25	1.20	1.11	0.98	0.89			
6			1.24	1.17	1.03	0.91				
16			1.12	1.03		0.80	0.70			
18			1.45	1.31	1.18					
Monthly means			**1.26**	**1.18**	**1.11**	**0.90**	**(0.80)**			
Departure from 3-year normal			**−0.10**	**−0.14**	**−0.14**	**−0.24**	**−0.27**			
P. M.										
Nov. 2			1.37	1.24	1.18	1.10			0.94	
3					1.13	1.03	0.94	0.85	0.78	0.71
5				1.26	1.14	1.05	0.98	0.91	0.85	0.81
6				1.10	1.00	0.91	0.83	0.78	0.70	
7			1.18	1.07	0.98	0.90				
14			1.14	0.85						
Monthly means			**1.23**	**1.10**	**1.09**	**1.00**	**0.92**	**0.85**	**0.82**	**(0.76)**
Departure from 3-year normal			**−0.17**	**−0.19**	**−0.12**	**−0.13**	**−0.15**	**−0.15**	**−0.12**	**−0.18**

TABLE 1.—*Solar radiation intensities during November, 1917*—Contd.

Santa Fe, N. Mex.

Date.	Sun's zenith distance.									
	0.0°	48.3°	60.0°	65.5°	70.7°	73.6°	75.7°	77.4°	78.7°	79.8°
	Air mass.									
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5
A. M.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Nov. 1		1.50	1.36							
3		1.58				1.24	1.19		1.15	
5		1.50	1.38							
6		1.45	1.39			1.29	1.22	1.14		
8		1.52	1.39			1.20	1.13	1.07	1.01	
16			1.24				1.11			
19									1.13	1.01
21						1.31	1.22	1.15		
Monthly means		**1.51**	**1.35**			**1.26**	**1.17**	**1.12**	**1.10**	**(1.01)**
Departure from 6-year normal		**−0.05**	**−0.12**			**−0.01**	**−0.03**	**−0.02**	**−0.06**	
P. M.										
Nov. 1			1.43	1.34	1.27	1.21	1.14	1.09		
3			1.38	1.35	1.26	1.16	1.13			
5			1.44	1.34	1.23	1.13				
8					1.25					
12					1.17	1.12	1.04	0.97		
16						1.17	1.13			
20				1.39	1.30	1.21				
22					1.27	1.23	1.17			
23			1.44	1.38	1.32	1.27				
Monthly means			**1.42**	**1.36**	**1.26**	**1.19**	**1.12**	**(1.03)**		
Departure from 2-year normal			**−0.03**	**−0.04**	**−0.04**	**−0.04**	**−0.04**	**−0.08**		

TABLE 2.—*Vapor pressures at pyrheliometric stations on days when solar radiation intensities were measured.*

Washington, D. C.			Madison, Wis.			Lincoln, Nebr.			Santa Fe, N. Mex.		
Dates.	8 a. m.	8 p. m.	Dates.	8 a. m.	8 p. m.	Dates.	8 a. m.	8 p. m.	Dates.	8 a. m.	8 p. m.
1917.	*mm.*	*mm.*	1917.	*mm.*	*mm.*	1917.	*mm.*	*mm.*	1917.	*mm.*	*mm.*
Nov. 1	4.37	3.15	Nov. 3	3.81	5.36	Nov. 2	3.15	4.57	Nov. 1	2.49	3.15
2	3.15	3.00	5	4.75	6.50	3	3.99	4.57	3	3.45	2.62
3	3.99	4.37	16	4.95	6.76	5	4.57	2.74	5	2.49	2.26
4	3.63	4.37	20	4.37	6.76	6	4.17	5.56	6	1.88	2.36
5	3.30	4.57				7	2.36	7.57	8	1.96	3.45
6	3.99	4.95				14	4.57	5.79	12	3.81	3.63
7	4.37	3.15				16	5.16	12.68	16	3.63	2.36
8	2.74	3.45				18	3.99	2.87	19	2.74	2.87
10	3.99	5.79							20	2.87	3.00
12	5.56	7.04							21	2.06	2.74
17	4.37	5.56							22	2.49	3.45
26	3.45	2.36							23	2.87	3.00

TABLE 3.—*Daily totals and departures of solar and sky radiation during November, 1917.*

[Gram-calories per square centimeter of horizontal surface.]

Day of month.	Daily totals.		Departures from normal.		Excess or deficiency since first of month.	
	Washington.	Madison.	Washington.	Madison.	Washington.	Madison.
1917.	*calories.*	*calories.*	*calories.*	*calories.*	*calories.*	*calories.*
Nov. 1	268	151	7	−46	7	−46
2	315	177	58	−18	65	−64
3	315	265	62	73	127	9
4	350	244	101	55	228	64
5	345	261	100	75	328	139
6	259	205	17	21	345	160
7	306	50	67	−131	412	29
8	329	137	92	−41	504	−12
9	246	178	12	2	516	−10
10	268	150	37	−23	553	−33
11	218	205	−11	34	542	1
12	195	38	−31	−130	511	−129
13	56	55	−167	−110	344	−239
14	195	119	−25	−44	319	−283
15	230	222	12	62	331	−221
16	198	222	−17	64	314	−157
17	231	195	19	39	333	−118
18	254	203	44	49	377	−69
19	246	112	39	−40	416	−109
20	237	204	32	54	448	−55
Decade departures					**−105**	**−22**
21	104	154	−98	6	350	−49
22	154	63	−46	−83	304	−132
23	206	131	9	−13	313	−145
24	104	99	−91	−43	222	−188
25	260	88	68	−52	290	−240
26	225	112	35	−27	325	−267
27	159	43	−29	−94	296	−361
28	52	115	−134	−21	162	−382
29	31	55	−153	−80	9	−462
30	13	66	−169	−68	−160	−530
Decade departures					**−608**	**−475**
Excess or deficiency since first of year. gr.-cal.					**−6,768**	**+147**
Excess or deficiency since first of year. per cent					−5.5	+0.1

OBSERVATIONS OF THE NEUTRAL POINTS OF ATMOSPHERIC POLARIZATION FROM GREAT HEIGHTS.[1]

By A. WIGAND.

[*Reprinted from* Science Abstracts, Sect. A, Sept. 29, 1917, §866.]

Observations of the positions of the neutral points of Arago and Babinet were made in the early morning of May 3, 1914, from a free balloon. The balloon started from Bitterfeld at 3:14 a. m., Middle European Time, and observations of polarization were obtained from 3:59 to 5:35 a. m., during which time the balloon rose from 3,100 to 5,850 meters. The angular distances of Arago's Point are plotted against the elevation of the sun and compared with corresponding observations made on the earth's surface, showing that the elevation from which the observations were made did not affect the position of the neutral point. Similarly the distances of Babinet's Point from the sun are shown to be unaffected by variation in height of the point of observation, within the limits of accuracy of observation.

The conclusion provisionally drawn from the few observations available is that the phenomena of polarization do not belong exclusively to the lower layers. As they show no appreciable change in the first 6,000 meters they are possibly to be considered as a property of the stratosphere.—*R. C[orless].*

SOME NUCLEI OF CLOUDY CONDENSATION—III.[2]

By J. AITKEN.

[*Reprinted from* Science Abstracts, Sect. A, Sept. 29, 1917, §864.]

The nuclei of the atmosphere, formerly termed by the author dust particles, but now recognized to be very much smaller than the ordinary particles of dust raised in a wind, have been the subject of a good deal of investigation. Of late it has been definitely stated by some workers that these nuclei are mere aggregations of ions and not of the nature of dust particles. The present investigation was carried out to test this theory, and incidentally many subsidiary experiments were made. A new piece of apparatus was devised in which the saturated sample of air in a test flask could readily and almost instantaneously be expanded, and thus given any degree of supersaturation within reasonable limits. The "size" of the nuclei is measured by the degree of supersaturation required to produce condensation upon them, a 2 per cent expansion of the air in the test flask being sufficient to cause condensation upon the larger nuclei, while higher degrees of supersaturation are required for the smaller ones, until a 25 per cent expansion is required to produce condensation on individual ions. The "size" of the nuclei measured in this way does not necessarily mean the relative dimensions, though probably not far from it.

With the aid of the new apparatus tests were made on the effect of heat acting on different materials, as a nucleus producer. It was found that when any material became sufficiently heated to cause an alteration in the flame in contact with it then nuclei were produced. This held in the case of glass, porcelain, alundum, and also with copper and other metals. This production of nuclei from heated surface affords some explanation of the wearing away of bars of grates and linings of furnaces in cases where these are not exposed to friction. Some metals, as magnesium, were found to have the

[1] Physikal. Ztschr., June 1, 1917, 18: 237-240.
[2] Proc., Roy. soc., Edinburgh, 1916-1917, 37: 215-245.

power of producing nuclei when cold, while others, as aluminum, had little effect. Experiments with ordinary air and with the pure air found in the neighborhood of Loch Awe both showed that whereas large nuclei were present, small nuclei requiring more than a 6 per cent expansion to produce condensation were generally absent. This did not support the theory that nuclei are aggregations of ions, since in this case nuclei of all sizes from that of a single ion upward would be expected. Some tests were made with air ionized by means of radium salts, but even after long intervals extending up to a day no tendency was observed for the ions to combine and produce large nuclei. It is therefore considered as proved that the "large ions of the atmosphere" are in reality nuclei to which an ion has become attached and given up its charge. The paper contains much detail information which can not be summarized in an abstract.—*J. S. Di[nes]*.

RELATION BETWEEN SUNLIGHT AND MOONLIGHT.[1]

By J. S. Dow.

[*Reprinted from* Science Abstracts, Sect. A, Sept. 29, 1917, §931.]

Taking sunslight to be equivalent to 10,000 candle-feet (for perpendicular incidence from an unclouded sky), the corresponding illumination from the full moon is calculated to be 0.02 candle-foot. The author finds this to be very near the value he obtained by actual measurement. The range of illumination between sunlight and moonlight is thus of the order of 1 to 500,000.—*C. P. B[utler]*.

[See this REVIEW for June, 1914, p. 347 for another estimate of the moon's brightness.]

MINUTE STRUCTURE OF THE SOLAR ATMOSPHERE.[2]

By G. E. HALE & F. ELLERMAN.

[*Reprinted from* Science Abstracts, Sect. A, Sept. 29, 1917, §873.]

A short summary is given of the result of an extensive investigation of spectroheliograms showing the structure of the solar atmosphere at various levels in comparison with that of the low-lying photosphere and sunspots. For the photosphere Langley's "rice grains" and "granules" are still the best standards for denoting the minute structure, the granules being about 0.3 second in diameter (say about 130 miles). Photographs taken with the spectroheliograph in calcium light can be made to show details at different levels according to the slit setting. The smallest calcium flocculi observed are less than 1 second in diameter. In the case of the highest levels shown by the dark hydrogen flocculi in Hα-light, the smallest flocculi are about 2 seconds in diameter. This seems to support the view that the photosphere and gaseous atmosphere above it are formed of columns of hot gases, rising by convection from the interior of the sun. To illustrates these difference of level a stereoscopic picture is given of a dark hydrogen flocculus floating over the region of a large spot group on 1915, August 7, the vortex action of the spots is also well shown by the bending of the hydrogen flocculus near the spot umbræ. It is concluded that the minute structure of the quiescent solar atmosphere resembles that of the photosphere. In disturbed regions, the small granular regions are replaced by slender filaments, lying side by side, resembling the structure of penumbræ of sunspots.—*C. P. B[utler]*.

[1] Illum. engr., London, April, 1917, **10**: 113-114.
[2] Proc., Nat. acad. sci., February, 1916, **2**: 102-108.

The present editor reprints below the last paragraph of the original proceedings of the National Academy of Sciences, February, 1916, **2**:108:

> We have shown in this paper that the minute structure of the quiescent solar atmosphere resembles that of the photosphere. In disturbed regions, the small granular elements (minute flocculi) are replaced by numerous slender filaments, lying side by side, and recalling the structure of the penumbra in sun spots. While these results appear to support the hypothesis that the solar atmosphere consists of parallel columns of ascending and expanding gases, which are drawn out horizontally in spot penumbræ and in disturbed regions of the chromosphere, such questions as the dimensions of the columns and the direction of motion and velocity of the vapor in sun spots and in the atmosphere about them are reserved for subsequent discussion.

WHY THE AXES OF THE PLANETS ARE INCLINED.

By Prof. WILLIAM H. PICKERING

(Harvard College Observatory, Mandeville, Jamaica, B. W. I.).

[*Reprinted from* Popular Astronomy, October, 1917, 25.]

[The intimate relation existing between the climates and meteorology of a planet and the inclination of its axis to the plane of the ecliptic, seems sufficient justification for introducing this astronomical discussion here—C. A., jr.]

This question is constantly asked by students of astronomy, and the answer generally given is either that it "just happened so," or else that "nobody knows." In point of fact the answer is not very far to seek. Imagine a large revolving gaseous mass condensed toward the center. Recent observations seem to show that at least one of the nebulæ revolves as one piece, as if it were a solid body, but in general there is no question but that in a loosely formed gaseous mass the outer portions will travel at a lower linear rate than the inner ones. Let figure 1 represent such a condensing gaseous mass, with a huge condensation at a and a relatively small one beginning to form at b. The shape of the latter is of no consequence, whether it is spherical from the beginning, or merely the portion of an arm of a spiral. In either case its outer portion revolves about a more slowly than its inner, as is indicated by the arrows, and if it finally condenses sufficiently to form an independent body, revolving about a in a positive direction, its rotation on its own axis will be *negative*, or as we usually describe it *retrograde*.

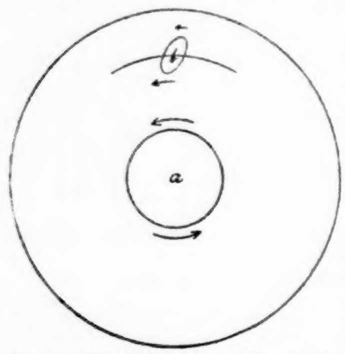

FIG. 1.—Illustrating the origin of the initially retrograde rotation of a satellite or a planet, *b*.

If this is the method by which the planets were formed, which seems not unlikely, why is it then that their rotation is found to be direct instead of retrograde? In point of fact the rotation of the two outermost *is* retrograde as has been known theoretically, from the direction of revolution of their satellites, for many years. Only recently this direction has been confirmed spectroscopically for Uranus at the Lowell Observatory (Lowell Observatory Bulletin No. 53) and the period of rotation found, $10^h\,50^m$. This period has been confirmed,

still more recently, by Mr. Campbell at Harvard (Circular 200).

Owing to the rotation of the planets on their axes a daily tide will be produced on each of them by the sun, but this tide can have no influence whatever on the direction of the rotation of the planets. But besides this daily tide an annual tide is also produced, the effect of which in general, although very small, is to slow down the rotation, and finally to make each planet constantly present the same face to the sun. The slowing-down process, however, is peculiar, and not at all what one would naturally expect. The simplest case to explain is that where the axis lies in the plane of the orbit, as is nearly the case at present with the planet Uranus (fig. 2). The effect of this annual tide, which is shown by the two bulging lines, is to tend to cause the planet to rotate about an axis perpendicular to its orbit. This force, or more strictly speaking, couple, acts continuously, and is indicated by the two short arrows. Its direction it will be noted lies at right angles to that of the couple producing precession.

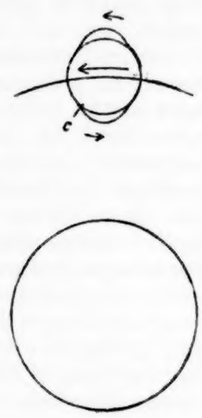

FIG. 2.—Illustrating present retrograde rotation of Uranus, inclination of axis 98°.

Owing to the rapid rotation on its axis, Uranus acts as a gyroscope, and refuses to shift its plane in the direction in which it is pulled, but does gradually yield in a direction at right angles to the pull. That is to say, its axis of rotation cants over, so that instead of revolving as at present in a retrograde direction, its axis will sooner or later lie exactly in the plane of the orbit [=plane of paper]. Instead of pole c being above the plane of the paper, it will coincide with it. Its inclination then instead of being 98° will become 90°. When this occurs we can no longer say that its rotation is retrograde any more than that it is direct. In fact it is neither the one nor the other.

But the process does not end here. After being reduced to 90° the inclination of the axis next becomes 89°, and the direction of motion is now positive, i. e., the rotation is direct. It continues to decrease steadily as the centuries pass, and will finally become 0°, which is the stable inclination and beyond which no change can occur. It will then be rotating on an axis exactly perpendicular to the plane of its orbit, and with a direct motion. This is the theoretical result that must necessarily occur, and the shifting of the plane of rotation can readily be illustrated practically by means of a gyroscope mounted within two rings, or a ring and a fork. Under these circumstances a slight pull to one side on the end of the axle, or any friction introduced on the vertical axle of the fork, will correspond to the annual tide.

In the case of the tide itself the pull is relatively very minute at present, but this was not the case when the planets were huge gaseous masses. The inclinations of the outer ones are Neptune 145°, Uranus 98°, Saturn 27°, and Jupiter 3°. The tidal pull increases very rapidly as we approach the sun, which is the chief reason that the inclination of Jupiter has now nearly reached its theoretical limit of 0°. While the original thin flattened solar nebula must have extended far beyond the present orbit of Neptune, the great great swirl that ultimately developed into the planet Jupiter must for a similar reason have been at least thirty million miles in diameter, and its age must be reckoned in thousands of millions of years. The inclinations of the two small terrestrial planets, the Earth and Mars, are both 23° and, doubtless owing to their small mass and consequent rapid cooling, they reached their present solid form before the tidal forces were able to complete their work. The diminution in their inclinations is still going on, but at an almost infinitesimal rate.

But have we any evidence other that Saturn and Jupiter formerly rotated in a retrograde direction? In 1901 it was shown that Saturn's ninth satellite revolved about the planet in a direction opposite to the revolution of all the other satellites, in short was retrograde. The explanation of this is clearly that when this outermost satellite was formed this was the actual direction of rotation of Saturn itself, and that, when by planetary inversion[1] the planet later turned over, as above explained, and assumed a direct rotation, the inner and younger satellites were formed, and therefore revolve as we now see them.[1] An attempt has lately been made to explain this retrograde revolution of the outer satellites of Saturn and Jupiter by accidental capture from outside. This theory seems unnecessary since the case is entirely covered by the tidal theory. The latter is the only one, however, that has ever been offered, as far as the writer is aware, to explain the high inclination of the equator of Uranus to its orbit, and the successively diminishing inclinations of the equators of the four large outer planets of our system. Whatever, therefore, the explanation of the retrograde revolution of their outer satellites may be, it is very certain that at an early date the direction of rotation of the four great planets themselves was retrograde.

[1] Instead of planetary, this might perhaps more properly be called Polar Inversion since the sun shows its influence as well as the planets. The sun's equator, as is well known, is inclined 5.7° to the invariable plane of the solar system. For a proposed explanation of this phenomenon see Annals, Harvard College Observatory, Cambridge, Mass., **61**:363. Even the spiral nebulæ exhibit the same influence. When the main nebula has a companion, as is the case with the Great Nebula in Andromeda (N. G. C. 224), the plane of the latter is nearly always markedly inclined to that of the former. (See also N. G. C. 4485 and 4536.)

SECTION II.—GENERAL METEOROLOGY.

SHALL WE REVISE OUR NOMENCLATURE FOR THERMOMETRIC SCALES?

By CHARLES FREDERICK MARVIN.

[Weather Bureau, Washington, D. C., Dec. 31, 1917.]

The present standard for exact thermometry is the normal centigrade scale of the constant-volume hydrogen thermometer as defined by the International Bureau of Weights and Measures. The constant volume is one liter and the pressure at the freezing point is one meter of mercury reduced to freezing and standard gravity. The scale is completely defined by designating the temperature of melting ice 0° and of condensing steam 100°, both under standard atmospheric pressure. All other thermometric scales that depend on the physical properties of substances may, by definition, be made to coincide at the ice point and the boiling point with the normal scale as above defined, but they will diverge more or less from it and from each other at all other points. However, by international consent it is customary in most cases to refer other working scales to the hydrogen scale.

Absolute or thermodynamic scale.

To obviate the difficulty which arises because thermometers of different types and substances inherently disagree except at the fixed points, Lord Kelvin proposed that temperatures be defined by reference to certain thermodynamic laws. This course furnishes a scale independent of the nature or properties of any particular substance. The resulting scale has been variously named the absolute, the thermodynamic, and more recently in honor of its author, the Kelvin scale. The temperature of melting ice by this scale on the centigrade basis is not as yet accurately known, but it is very nearly 273.13°, and that of the boiling point 373.13°.

Approximate absolute scale.

Occasions arise with increasing frequency in which meteorologists, physicists, and others in dealing with problems of temperature are required to use an absolute scale or an approximation thereto, and to publish temperature data in those units. It is not convenient, and in many cases not necessary, to adhere strictly to the true thermodynamic scale. In fact, the general requirements of science are very largely met by the use of an *approximate* absolute scale which, for the centigrade system, is defined by the equation

$$T = 273. + t° \text{ Cent.}$$

The observed quantity, $t°$, may be referred to the normal hydrogen centigrade scale or be determined by any acceptable thermometric method. This approximate scale is often called the "absolute" or the Kelvin scale, perhaps for the sake of brevity or convenience. Of course, no one can disregard the technical differences between the real and the false, or approximate absolute scales.

This scale differs from the true Kelvin scale, first, because 273° is not the exact value of the ice point on the Kelvin scale; second, because each observed value of $t°$ other than 0° or 100° requires a particular correction to convert it to the corresponding value on the Kelvin scale. These corrections will differ according to the kind of thermometer used in obtaining the value $t°$, and while they are small for temperatures between 0° and 100° they are large at extreme temperatures and are important in all questions involving thermometric precision.

The *approximate* absolute scale is sufficiently exact for nearly all purposes, it is most convenient in computations and in the publication of results; further, its numerical quantities are strictly homogeneous, and should any necessity arise data published in its units may be readily reduced to the absolute Kelvin scale by simply applying the appropriate correction for the zero point of the scale—about 0.13° C.—and the other appropriate correction to reduce the observed temperature, $t°$, to the true thermodynamic temperature. It is thus clear that much confusion and uncertainty of terminology and meaning would be obviated, and Kelvin's suggestion properly appreciated, if scientists would agree to ***give the approximate absolute scale a particular name of its own*** and reserve the name "absolute" for the scale that is truly absolute, viz, Kelvin's absolute thermodynamic scale.

In accordance with the foregoing ideas, the thermometric scale and nomenclature in the centigrade system may be set forth in the following manner:

Thermometric nomenclature.

AS IT IS.

	Fiducial points. Freezing point.	Boiling point.
Centigrade scale		
Normal hydrogen constant-pressure thermometer	0°	100°
Thermodynamic scale Absolute scale Kelvin scale Approximate or "near-absolute" scale defined by the equation— $T = 273 + t°$ Cent.	All frequently loosely designated Absolute Scale in scientific literature.	

AS IT SHOULD BE.

Centigrade scale	0°	100°
Thermodynamic scale Absolute scale Kelvin scale	273.13° Strictly synonymous and strictly one ideal scale.	373.13°
"Approximate-absolute (?)"	273°	373°

Let us prevent confusion and uncertainty, make the meaning of scientific writings clear and distinct, by giving an appropriate name to the scale

$$T = 273 + t° \text{ Cent.}$$

Such a name will have the significance of—

Quasi-absolute, symbol Q or A_q.
Approximate absolute, symbol A_a.
Pseudo-absolute, symbol P.

It should be a short word if possible and suggest a good symbol for its abbreviation. The above list of names is tentative and suggestions from others are requested.

SOME RESEARCHES IN THE FAR EASTERN SEASONAL CORRELATIONS.

(FOURTH NOTE.) [1]

By T. OKADA.

[Dated: Central Meteorological Observatory, Tokyo, June 20, 1917; corrected for this REVIEW by the author Sept. 24, 1917.]

(Journal of the Royal Meteorological Society of Japan, July, 1917, **36** : 65-78.)

1. *Correlation between the April pressure-difference Ponta Delgada–Stykkisholm and the mean of the following August temperatures at Nemuro and Miyako.*—In the Third Note I traced a parallelism between the variation of the difference of the April barometric pressure at Ponta Delgada, Azores, and Stykkisholm, Iceland, and the mean of the following August temperatures at Nemuro and Miyako, in northern Japan. The present Note gives the materials discussed and the correlation coefficient computed. The Stykkisholm data are based on Dr. Lockyer's pressure table (see this REVIEW, June, 1917, p. 299, footnote 3), supplemented by material extracted from the Meteorologisk Aarbog of the Danish Meteorological Institute. Table 1, below, gives the pressure and temperature data for the four stations under discussion, x standing for the variation of the difference of the April pressure Azores–Iceland and q for the variation of the August mean temperature Nemuro + Miyako.

TABLE 1.—*April pressure-difference Ponta Delgada-Stykkisholm correlated with the mean August temperature at Nemuro and Miyako.*

Years.	Pressure. Ponta Delgada.	Pressure. Stykkisholm.	Pressure. Difference	Pressure. $\delta(p-s)$ or x.	Temperature. Nemuro.	Temperature. Miyako.	Temperature. Mean variation of w and m.	$x.q$	x^2	q^2
	p	s	$(p-s)$.	x	w	m	q			
	mm.	*mm.*	*mm.*		°*C.*	°*C.*				
1883	764.9	750.6	14.3	......	19.9	20.9	......	......	......	......
1884	59.8	56.5	3.3	−11.0	16.4	20.0	−2.2	+24.20	121.00	4.84
1885	66.7	53.7	13.0	+ 9.7	16.9	22.6	+1.6	+15.52	94.09	2.56
1886	761.5	755.8	5.7	− 7.3	19.8	24.8	+2.6	−18.98	53.29	6.76
1887	59.1	60.6	−1.5	− 7.2	18.8	22.2	−1.8	+12.97	51.84	3.24
1888	66.2	61.0	5.2	+ 6.7	17.4	22.9	−0.4	− 2.68	44.89	0.16
1889	68.9	54.6	14.3	+ 9.1	18.2	22.1	0.0	0.00	82.81	0.00
1890	67.5	52.5	15.0	+ 0.7	19.3	22.5	+0.8	+ 0.56	0.49	0.64
1891	762.4	758.9	3.5	−11.5	17.1	21.0	−1.9	+21.85	132.25	3.61
1892	64.1	57.2	6.9	+ 3.4	17.3	23.0	+1.1	+ 3.74	11.56	1.21
1893	62.7	54.8	7.9	+ 1.0	17.3	22.6	−0.2	− 0.20	1.00	0.04
1894	66.6	52.6	14.0	+ 6.1	17.8	23.2	+0.6	+ 3.66	37.21	0.36
1895	62.0	56.0	6.0	− 8.0	15.8	21.6	−1.8	+14.40	64.00	3.24
1896	768.7	752.6	16.1	+10.1	17.7	23.0	+1.7	+17.17	102.01	2.89
1897	67.4	46.5	20.9	+ 4.8	17.0	21.5	−1.1	− 5.28	23.04	1.21
1898	65.1	48.7	16.4	− 4.5	16.4	22.8	+0.4	− 1.90	20.25	0.16
1899	65.4	59.1	6.3	−10.1	15.4	22.0	−0.9	+ 9.09	102.01	0.81
1900	65.3	54.6	10.7	+ 4.4	18.2	23.5	+2.2	+ 9.68	19.36	4.84
1901	764.8	752.0	12.8	+ 2.1	17.9	22.8	−0.5	− 1.05	4.41	0.25
1902	61.1	59.3	1.8	−11.0	14.5	18.4	−3.9	+42.90	121.00	15.21
1903	64.7	57.4	7.3	+ 5.5	15.9	20.6	+1.8	+ 9.90	30.25	3.24
1904	69.6	47.7	21.9	+14.6	18.5	22.2	+2.1	+30.66	213.16	4.41
1905	63.7	62.5	1.2	−20.7	14.7	18.2	−3.9	+80.73	428.49	15.21
1906	768.4	752.1	16.3	+15.1	15.7	19.6	+1.2	+18.12	228.01	1.44
1907	66.2	52.9	13.3	− 3.0	17.5	24.2	+3.2	− 9.60	9.00	10.24
1908	65.1	62.5	2.6	−10.7	17.8	22.6	−0.2	+ 2.14	111.49	0.04
1909	64.1	54.6	9.5	+ 6.9	16.8	21.6	−1.5	−10.35	47.61	2.25
1910	63.1	59.0	4.1	− 5.4	16.3	20.5	−0.8	+ 4.64	29.16	0.64
1911	763.8	758.8	5.0	+ 0.9	15.9	22.1	+0.6	+ 0.54	0.81	0.36
1912	67.7	57.3	10.4	+ 5.4	15.6	21.6	−0.4	− 2.17	29.16	0.16
Sums	......	......	......	......	......	......	......	+270.26	2,213.65	90.02

[1] For the previous Notes see this REVIEW, January, 1916, **44** : 17: May, 1917, **45** : 238, June, 1917, **45** : 299.

In order to eliminate the secular variation which is superposed on the variation under consideration, I have computed the coefficient of correlation for the variations of the pressure and temperature instead of for their deviations from the mean values. Let r_{qx} be the correlation-coefficient for the April pressure-difference Ponta Delgada–Stykkisholm and the August temperature Nemuro + Miyako, and let E_{qx} be the probable error; then we have

$$r_{qx} = + \frac{270.26}{(2213.65)\ \ (90.02)^{1/2}} = +\ 0.61$$

$$E_{qx} = \pm\ 0.6745 \frac{1 - (0.61)^2}{(29)^{1/2}} = \pm\ 0.079$$

From the above we see that the parallelism between both elements is very striking during these 29 years, from 1884 to 1912.

2. *Correlation between the March pressure-difference Zikawei–Miyazaki and the mean of the following August temperatures at Nemuro and Miyako.*—In my First Note I traced a remarkable parallelism between the barometric gradient at Zikawei (near Shanghai) for March and the mean temperature in northern Japan for the following summer. In the present note will be given the result of my computation of the correlation-coefficient between the variation of the pressure-difference Zikawei–Miyazaki for March and the mean of the following August temperatures at Nemuro and Miyako. The Zikawei Observatory data from 1883 to 1910 have been extracted from the Bulletin des Observations of that observatory, and those for 1911 and 1912 I owe to the kindness of Father L. Froc, director of the same. The temperature data for the Japanese stations have been taken from the annual reports of the Central Meteorological Observatory, Tokyo. The actual values of the quantities discussed are graphically presented in figure 1.

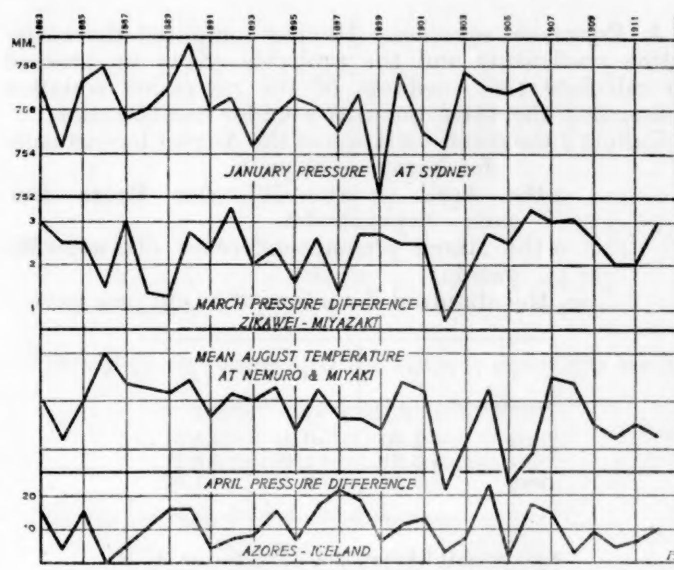

FIG. 1.—Graphic comparison of the elements correlated in this Fourth Note.

TABLE 2.—*Correlation of the March pressure-difference Zikawei—Miyazaki with the mean of the following August temperatures Nemuro + Miyako (q=mean variation of latter).*

Years.	Pressure.					$q.y$	$x.y$
	Zikawei.	Miyazaki.	(Zik.—Mi.)	δ(Zik.—Mi.)=y.	y^2		
	mm.	*mm.*	*mm.*				
1883	765.5	762.5	3.0				
1884	64.7	62.1	2.6	−0.4	0.16	+ 0.88	+ 4.40
1885	66.6	64.0	2.6	0.0	0.00	0.00	0.00
1886	765.6	764.1	1.5	−1.1	1.21	− 2.86	+ 8.03
1887	66.3	63.3	3.0	+1.5	2.25	− 2.70	−10.80
1888	65.0	63.6	1.4	−1.6	2.56	+ 0.64	−10.72
1889	65.7	64.4	1.3	−0.1	0.01	0.00	− 0.91
1890	66.2	63.4	2.8	+1.5	2.25	+ 1.20	+ 1.05
1891	765.9	763.6	2.3	−0.5	0.25	+ 0.95	+ 5.75
1892	66.7	63.4	3.3	+1.0	1.00	+ 1.10	+ 3.40
1893	65.4	63.5	1.9	−1.4	1.96	+ 0.28	− 1.40
1894	65.7	63.4	2.3	+0.4	0.16	+ 0.24	+ 2.44
1895	65.1	63.5	1.6	−0.7	0.49	+ 1.26	+ 5.60
1896	767.3	764.7	2.6	+1.0	1.00	+ 1.70	+10.10
1897	65.7	64.4	1.3	−1.3	1.69	+ 1.43	− 6.24
1898	66.0	63.3	2.7	+1.4	1.96	+ 0.56	− 6.30
1899	66.0	63.3	2.7	0.0	0.00	0.00	0.00
1900	65.9	63.4	2.5	−0.2	0.04	− 0.44	− 0.88
1901	767.6	765.1	2.5	0.0	0.00	0.00	0.00
1902	63.7	63.0	0.7	−1.8	3.24	+ 7.02	+19.80
1903	63.9	62.2	1.7	+1.0	1.00	+ 1.80	+ 5.50
1904	65.2	62.6	2.6	+0.9	0.81	+ 1.89	+13.14
1905	66.7	64.2	2.5	−0.1	0.01	+ 0.39	+ 2.07
1906	766.5	763.4	3.1	+0.6	0.36	+ 0.72	+ 9.06
1907	66.0	63.1	2.9	−0.2	0.04	− 0.64	+ 0.60
1908	67.0	64.1	2.9	0.0	0.00	0.00	0.00
1909	66.7	64.1	2.6	−0.3	0.09	+ 0.45	− 2.07
1910	65.3	63.5	1.8	−0.8	0.64	+ 0.72	+ 4.32
1911	764.5	762.7	1.8	0.0	0.00	0.00	0.00
1912	65.7	62.8	2.9	+1.1	1.21	− 0.44	+ 5.94
Sums					24.39	+16.15	+61.88

From the data given in Table 2 I have computed the correlation coefficients and have obtained the following:

$$r_{qy} = +\frac{16.15}{(24.39)^{1/2}\ (90.02)^{1/2}} = +0.31; \qquad E_{qy} = \pm 0.113.$$

$$r_{xy} = +\frac{61.88}{(2213.65)^{1/2}\ (24.39)^{1/2}} = +0.27; \qquad E_{xy} = \pm 0.116.$$

3. Regression equation.—Having computed the correlation coefficients and the probable errors we proceed to calculate the constants of the regression equation connecting the three quantities under consideration.

Calling q the mean variation of the August temperature for Nemuro + Miyako,

x the April pressure-difference Ponta Delgada – Stykkisholm,

y the March pressure-difference Zikawei – Miyazaki,

σ_x the standard deviation of x, etc., we have

	q	x	y
q	+1.00	+0.61	+0.31
x	+0.61	+1.00	+0.27
y	+0.31	+0.27	+1.00

$$r_{qx} = +0.61, \quad \sigma_x = \sqrt{22.1365} = 47.0$$

$$r_{qy} = +0.31, \quad \sigma_y = \sqrt{24.39} = 4.9$$

$$r_{xy} = +0.27, \quad \sigma_q = \sqrt{90.02} = 9.5$$

Let us assume that

$$q = ax + by,$$

and try to calculate a and b by the method of least squares using the above data. The normal equations are

$$\Sigma qx = a\Sigma x^2 + b\Sigma xy,$$

$$\Sigma qy = a\Sigma xy + b\Sigma y^2,$$

or

$$\frac{\Sigma qx}{\Sigma x^2} = a + b\frac{\Sigma yx}{\Sigma x^2}, \quad \frac{\Sigma qy}{\Sigma y^2} = a\frac{\Sigma xy}{\Sigma y^2} + b.$$

Since

$$r_{qx} = \frac{\Sigma qx}{\sqrt{\Sigma x^2}\sqrt{\Sigma q^2}}, \text{ and } r_{qy} = \frac{\Sigma qy}{\sqrt{\Sigma y^2}\sqrt{\Sigma q^2}}.$$

we have

$$r_{qx}\frac{\sigma_q}{\sigma_x} = a + br_{yx}\frac{\sigma_y}{\sigma_x}, \quad r_{qy}\frac{\sigma_q}{\sigma_y} = ar_{xy}\frac{\sigma_x}{\sigma_y} + b.$$

Solving these equations we get

$$a = \frac{(r_{qx} - r_{qy}r_{xy})\frac{\sigma_q}{\sigma_x}}{1-(r_{xy})^2},$$

$$b = \frac{(r_{qy} - r_{qx}r_{xy})\frac{\sigma_q}{\sigma_y}}{1-(r_{xy})^2}.$$

Inserting the values of r_{qx}, r_{qy}, etc., into the above equations we have

$$a = \frac{(0.61 - 0.31 \times 0.27) \times 9.5/47}{1-(0.27)^2} = 0.115$$

$$b = \frac{(0.31 - 0.61 \times 0.27) \times 9.5/4.9}{1-(0.27)^2} = 0.648,$$

therefore

$$q = 0.115x + 0.648y, \tag{1}$$

or the variation of the mean August temperature for Nemuro + Miyako equals 0.115 times the variation of the April pressure-difference Ponta Delgada–Stykkisholm plus 0.648 times the variation of the March pressure-difference Zikawei–Miyazaki.

Table 3 contains the departures of the calculated values from the actually observed ones.

TABLE 3.—*Comparison of the calculated with the observed values of q (variation of the mean August temperature for Nemuro–Miyako).*

$$q = 0.115x + 0.648y.$$

Years.	x	y	Temperature variation, q		
			Calculated	Observed.	Difference Cal.—Obs.
			°C.	°C.	°C.
1884	−11.0	−0.4	−1.5	−2.2	+0.7
1885	+ 9.7	0.0	+1.1	+1.6	−0.5
1886	− 7.3	−1.1	−1.6	+2.6	*−4.2
1887	− 7.2	+1.5	−1.8	−1.8	0.0
1888	+ 6.7	−1.6	−0.3	−0.4	+0.1
1889	+ 9.1	−0.1	+1.0	0.0	+1.0
1890	+ 0.7	+1.5	+1.1	+0.8	+0.3
1891	−11.5	−0.5	−1.4	−1.9	+0.5
1892	+ 3.4	+1.0	+1.0	+1.1	−0.1
1893	+ 1.0	−1.4	−0.8	−0.2	−0.6
1894	+ 6.1	+0.4	+1.0	+0.6	+0.4
1895	− 8.0	−0.7	−1.0	−1.8	+0.8
1896	+10.1	+1.0	+1.8	+1.7	+0.1
1897	+ 4.8	−1.3	−0.3	−1.1	+0.8
1898	− 4.5	+1.4	+0.4	+0.4	0.0
1899	−10.1	0.0	−1.2	−0.9	−0.3
1900	+ 4.4	−0.2	+0.4	+2.2	−1.8
1901	+ 2.1	0.0	+0.2	−0.5	*+0.7
1902	−11.0	−1.8	−2.4	−3.9	+1.5
1903	+ 5.5	+1.0	+1.3	+1.8	−0.5
1904	+14.6	+0.9	+2.3	+2.1	+0.2
1905	−20.7	−0.1	−2.4	−3.9	+1.5
1906	+15.1	+0.6	+2.1	+1.2	+0.9
1907	− 3.0	−0.2	−0.5	+3.2	*−3.7
1908	−10.7	0.0	−1.2	−0.2	−1.0
1909	+ 6.9	−0.3	+0.6	−1.5	*+2.1
1910	− 5.4	−0.8	−1.1	−0.8	−0.3
1911	+ 0.9	0.0	+0.1	+0.6	−0.5
1912	+ 5.4	+1.1	+1.3	−0.4	*+1.7

* Variations of opposite sign.

A glance at the table shows us that the calculated and observed variations of the August temperature for Nemuro+Miyako are in good agreement, barring a few exceptions, or that at least their signs are in harmony. Hence it may be of practical value for the purpose of issuing the seasonal forecast.

4. *Correlation between the pressure-variation at Sydney for January and the temperature-variation at Nemuro+Miyako for the following August.*—It has been found that the variations of the barometric pressure at Sydney, Australia, for January are in harmony with those of the air temperature at Nemuro-Miyako for the following August. The pressure data for Sydney for 1883 to 1907 have been taken from Dr. Lockyer's tables (loc. cit.). Table 4 gives these pressure data for Sydney and the temperature data for the Japanese stations.

TABLE 4.—*Correlation between January pressure variation at Sydney, z, and the variation in the following August temperature at Nemuro-Miyako,* q.

Years.	Sydney pressures.		q	$z.q$	z^2	q^2
	Obs.	Variation, z				
	mm.	*mm.*	*°C.*		*mm.*	*°C.*
1883	757.1					
1884	54.3	−2.8	−2.2	6.16	7.84	4.84
1885	57.1	+2.8	+1.6	4.48	7.84	2.56
1886	757.9	+0.8	+2.6	2.08	0.64	6.76
1887	55.6	−2.3	−1.8	4.14	5.29	3.24
1888	56.1	+0.5	−0.4	−0.20	0.25	0.16
1889	57.0	+0.9	0.0	0.00	0.81	0.00
1890	58.7	+1.7	+0.8	1.36	2.89	0.64
1891	756.1	−2.6	−1.9	4.94	6.76	3.61
1892	56.6	+0.5	+1.1	0.55	0.25	1.21
1893	54.1	−2.5	−0.2	0.50	6.25	0.04
1894	55.9	+1.8	+0.6	1.08	3.24	0.36
1895	56.9	+1.0	−1.8	−1.80	1.00	3.24
1896	756.2	−0.7	+1.7	−1.19	0.49	2.89
1897	55.1	−1.1	−1.1	1.21	1.21	1.21
1898	56.8	+1.7	+0.4	0.68	2.89	0.16
1899	51.9	−4.9	−0.9	4.41	24.01	0.81
1900	57.8	+5.9	+2.2	12.98	34.81	4.84
1901	755.1	−2.7	−0.5	1.35	7.29	0.25
1902	54.3	−0.8	−3.9	3.12	0.64	15.21
1903	57.8	+3.5	+1.8	5.60	12.25	3.24
1904	57.0	−0.8	+2.1	−1.69	0.64	4.41
1905	56.8	−0.2	−3.9	1.28	0.04	15.21
1906	757.3	+0.5	+1.2	0.60	0.25	1.44
1907	55.4	−1.9	+3.2	−6.08	3.61	10.24
Sums				45.56	131.19	86.57

From the data in Table 4 I have deduced the correlation-coefficient and the probable error,

$$r_{qz} = +\frac{(45.56)}{(131.19)^{1/2}\,(86.57)^{1/2}} = +0.49;\quad E_{qz} = \pm 0.106.$$

5. Again, I have computed the correlation-coefficients of any two of the four quantities q, x, y, and z, using the data for the 24 years from 1884 to 1907, inclusive. The following are the results of my computations:

$$r_{qx} = \frac{\Sigma qx}{\sqrt{\Sigma x^2}\sqrt{\Sigma q^2}} = +\frac{275.46}{\sqrt{1995.42}\sqrt{86.57}} = +0.67,\quad E_{qx} = \pm 0.076;$$

$$r_{qy} = \frac{\Sigma qy}{\sqrt{\Sigma q^2}\sqrt{\Sigma y^2}} = +\frac{15.42}{\sqrt{86.57}\sqrt{22.45}} = +0.35,\quad E_{qy} = \pm 0.121;$$

$$r_{qz} = \frac{\Sigma qz}{\sqrt{\Sigma q^2}\sqrt{\Sigma z^2}} = +\frac{44.56}{\sqrt{86.57}\sqrt{131.19}} = +0.43,\quad E_{qz} = \pm 0.106;$$

$$r_{xz} = \frac{\Sigma zx}{\sqrt{\Sigma z^2}\sqrt{\Sigma x^2}} = +\frac{197.83}{\sqrt{131.19}\sqrt{1995.42}} = +0.39,\ E_{xz} = \pm 0.117;$$

$$r_{xy} = \frac{\Sigma xy}{\sqrt{\Sigma x^2}\sqrt{\Sigma y^2}} = +\frac{53.69}{\sqrt{1995.42}\sqrt{22.45}} = +0.25,\quad E_{xy} = \pm 0.129;$$

$$r_{yz} = \frac{\Sigma yz}{\sqrt{\Sigma y^2}\sqrt{\Sigma z^2}} = +\frac{10.62}{\sqrt{22.45}\sqrt{131.19}} = +0.20,\quad E_{yz} = \pm 0.132;$$

$$\sigma_x = \sqrt{1995.4} = 44.67 \quad \sigma_y = \sqrt{22.45} = 4.74$$

$$\sigma_z = \sqrt{131.19} = 11.45 \quad \sigma_q = \sqrt{86.57} = 9.30$$

6. *Regression equation resumed.*—In Paragraph 4 I have obtained a regression equation

$$q = 0.115x + 0.648y,$$

for the case of two variables x and y. In the present case in which the third variable z is available we shall assume that

$$q = ax + by + cz.$$

Then, in applying the method of least squares we obtain the following normal equations:

$$\Sigma qx = a\Sigma x^2 + b\Sigma xy + c\Sigma zx,$$

$$\Sigma qy = a\Sigma xy + b\Sigma y^2 + c\Sigma zy,$$

$$\Sigma qz = a\Sigma xz + b\Sigma yz + c\Sigma z^2.$$

Expressing in terms of the correlation-coefficients and the standard deviations we have

$$r_{qx}\frac{\sigma_q}{\sigma_x} = a + br_{xy}\frac{\sigma_y}{\sigma_x} + cr_{xz}\frac{\sigma_z}{\sigma_x},$$

$$r_{qy}\frac{\sigma_q}{\sigma_y} = ar_{xy}\frac{\sigma_x}{\sigma_y} + b + cr_{yz}\frac{\sigma_z}{\sigma_y},$$

$$r_{qz}\frac{\sigma_q}{\sigma_z} = ar_{xz}\frac{\sigma_x}{\sigma_z} + br_{yz}\frac{\sigma_y}{\sigma_z} + c.$$

In the present problem these constants are

	q	x	y	z
q	+1.00	+0.67	+0.35	+0.43
x	+0.67	+1.00	+0.25	+0.39
y	+0.35	+0.25	+1.00	+0.20
z	+0.43	+0.39	+0.20	+1.00

and

$$\sigma_x = \sqrt{1995.4} = 44.67,\quad \sigma_y = \sqrt{22.45} = 4.74,$$
$$\sigma_x = \sqrt{131.19} = 11.45,\quad \sigma_q = \sqrt{86.57} = 9.30.$$

Putting these values into the normal equations we have

$$0.1395 = a + 0.0265b + 0.1000c,$$
$$0.6867 = 2.3560a + b + 0.4831c,$$
$$0.3492 = 1.5211a + 0.0828b + c,$$

Solving for a, b, and c, we get

$$a = 0.117,\quad b = 0.284,\quad c = 0.149,$$

Hence the regression equation becomes

$$q = 0.117x + 0.284y + 0.149z, \tag{2}$$

or the variation of the mean August temperature for Nemuro-Miyako equals 0.117 times the variation of the April pressure difference Ponta Delgada—Stykkisholm

plus 0.284 times the variation of the March pressure-difference Zikawei—Miyazaki plus 0.149 times the variation of the January pressure Sidney, N. S. W.

Table 5 presents the departures of the calculated values of the variations of the August temperature for Nemuro-Miyako from the actual values.

TABLE 5. *Differences between the calculated and actually observed values of* q *(variation of the mean August temperature for Nemuro-Miyako), as computed by the formula*

$$q=0.117x+0.284y+0.149z.$$

Years.	x	y	z	Variation of mean August temperature Nemuro + Miyako, q		
				Calculated.	Observed.	Calculated—Observed.
	mm.	*mm.*	*mm.*	°*C.*	°*C.*	°*C.*
1884	−11.0	−0.4	−2.8	−1.8	−2.2	+0.4
1885	+ 9.7	0.0	+2.8	+1.5	+1.6	−0.1
1886	− 7.3	−1.1	+0.8	−1.1	+2.6	*−3.7
1887	− 7.2	+1.5	−2.3	−0.7	−1.8	+1.1
1888	+ 6.7	−1.6	+0.5	+0.4	−0.4	*+0.8
1889	+ 9.1	−0.1	+0.9	+1.2	0.0	+1.2
1890	+ 0.7	+1.5	+1.7	+0.8	+0.8	+0.0
1891	−11.5	−0.5	−2.6	−1.8	−1.9	+0.1
1892	+ 3.4	+1.0	+0.5	+0.8	+1.1	−0.3
1893	+ 1.0	−1.4	−2.5	+0.1	−0.2	−0.3
1894	+ 6.1	+0.4	+1.8	+1.1	+0.6	+0.5
1895	− 8.0	−0.7	+1.0	−0.9	−1.8	+0.9
1896	−10.1	+1.0	−0.7	+1.4	+1.7	−0.3
1897	+ 4.8	−1.3	−1.1	−0.0	−1.1	+1.1
1898	− 4.5	+1.4	+1.7	+0.2	+0.4	+0.2
1899	−10.1	0.0	−4.9	−1.9	−0.9	−1.0
1900	+ 4.4	−0.2	+5.9	+1.3	+2.2	−0.9
1901	+ 2.1	0.0	−2.7	−0.2	−0.5	+0.3
1902	−11.0	−1.8	−0.8	−1.9	−3.9	+2.0
1903	+ 5.5	+1.0	+3.5	+1.4	+1.8	−0.4
1904	+14.6	+0.9	−0.8	+1.9	+2.1	−0.2
1905	−20.7	−0.1	−0.2	−2.4	−3.9	+1.5
1906	+15.1	+0.6	+0.5	+2.1	+1.2	+0.9
1907	− 3.0	−0.2	−1.9	−0.8	+3.2	*−4.0

* Calculated and observed values are of opposite sign.

6. *On the possibility of forecasting the August temperature for northern Japan.*—In northern Japan the August temperature is the dominant factor [2] for the rice crop of the year. When the air temperature in August is higher than the average Japan may expect a good harvest. On the contrary when the August temperature is lower than the normal we are to anticipate a very bad harvest. In recent times 1902, 1905, and 1913 had abnormally cool Augusts. In consequence there was failure of the rice crop, which resulted in a terrible famine in most of northern Japan. Attention of scientists has been called to the cause of this abnormal low temperature. Forecasting the approximate temperature for August many months in advance is the problem that confronts [the Japanese]. Some of them have found a close relation existing between the hydrographical and meteorological phenomena off our east coast, and have proposed to take systematic observations of sea temperature for the prediction of the general character of the summer. But it is not easy to make systematic observations of sea temperature. Moreover there is at present no special organization or institute for making systematic hydrographical observations on our [Japan's] coast. I have therefore intended, in default of better, to make a tentative application of statistical methods for the solution of the problem. My method of seasonal forecasting is based on the facts that the temperature variation in northern Japan for August is in harmony with that of the April pressure difference, Azores—Iceland, and that of the March pressure difference, Zikawei—Miyazaki. But, as in all efforts at the solution of seasonal forecasting, there are some tantalizing exceptions in this harmony of the pressure and temperature variations. Hence we can not hope to establish a definite law of prediction or to calculate the approximate August temperature many months in advance.

But the regression equation $q=0.115x+0.648y$, imperfect as it is, will serve to show at least the sense of variation of the air temperature of the coming August at the beginning of May when we have the telegraphic reports of the mean pressures at Ponta Delgada and Stykkisholm for April and those at Zikawei and Miyazaki for March. When the Sydney, N. S. W., pressure for January is available the regression equation

$$q=0.117x+0.284y+0.149z$$

is to be used.

It must be remarked here that the number of years for which data are available is inadequate for a correct knowledge of the relationships involved and the factors available are scanty. Hence future information and the introduction of new factors [3] are likely to modify the relative importance of the terms involved in the above equations to an appreciable extent.

[2] A detailed discussion on the relation between the rice crop and the temperature, together with the correlation with the pressure variations, Azores-Iceland, Zikawei-Miyazaki, etc., will be given in a further note.

[3] The variation of the pressure at Cordoba, Argentine Republic, for April is in harmony with that of the August temperature in northern Japan.—*Author.*

SUN SPOTS, MAGNETIC STORMS, AND RAINFALL.[1]

By HENRYK ARCTOWSKI, Ph.D.

[Dated: Hastings-on-Hudson, N. Y., Sept. 13, 1917.]

Utilizing the results of Wolf's daily sunspot observations, Loomis noticed the fact that on the days of magnetic storms the sunspot relative numbers are much above the average and that secondary maxima occur 4 days before and 3 days after those of magnetic disturbances.

Recently this fact has been partially verified by Lord Kelvin.

On the other hand it is well known that Terby, then later Marchand, and finally Maunder, have admitted that magnetic storms frequently coincide with the passage of a sunspot through the central meridian—that Veeder, on the contrary, advocated a predominant influence of the appearance of sunspots on the eastern limb and that Riccò noticed the fact that very frequently magnetic disturbances occur about 45 hours after the passage of a sunspot through the meridian.

Without further statistical verification Arrhenius deduced from Riccò's observations that the magnetic storms are due to particles, carrying negative electricity, conveyed from the sun by the pressure of radiation.

Since the correlation noticed by Loomis really exists, at least as far as the principal maximum is concerned, it seemed interesting to me to verify which of the three hypotheses concerning the position occupied by the sunspots producing auroras and magnetic storms is correct.

It is easy to understand the importance of the question.

[1] Author's abstract of "Note sur une corrélation entre orages magnétiques et la pluie;" "Positions héliographique des taches solaires et orages magnétiques." Par *Henryk Arctowski.* Mem., Soc. degli spettrosc. ital., 1917, 6 (ii): 33–36.

A sunspot may be considered as a rupture of the photosphere.

The radiations of a sunspot are different from the average radiation of the photosphere.

The correlation between the frequency variation of sunspots and the magnetic phenomena is a well-established fact.

Therefore, one may suspect in sunspots some *particular kind of radiation*, capable of producing our terrestrial magnetic disturbances and polar auroras.

Now the question is: Can simple statistics settle the question of the nature of this radiation?

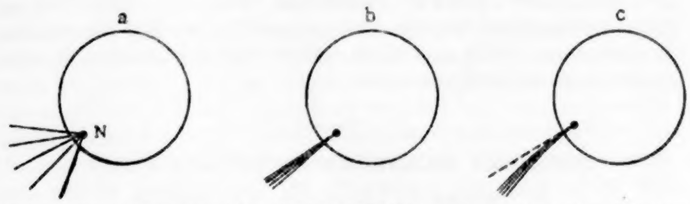

FIG. 1.—Sketch illustrating three different manners in which possible solar radiations might be sent out into space from a sunspot *N*.

Suppose a sunspot *N* (fig. 1). For the radiation producing the magnetic storm one may presume the three cases *a*, *b*, and *c*, sketched in.

Considering, for the days of magnetic storms, the distribution of sunspots separately east and west of the central meridian, and making the tabulations according to the distances from the center of the solar disk, we will have to find:

In case *a*, no particular maxima except such maxima as may be due to the effect of perspective.

In case *b*, a maximum of most central positions. In case *c*, 2 maxima, one east, and the other west of the central meridian, for positions of about 45° from the center of the disk.

I made the calculations for the dates of magnetic storms observed in Porto Rico during the years 1903 to 1908; for those observed at Bombay from 1874 to 1892; and also for those observed at Greenwich from 1882 to 1903; and from the numerical results thus obtained I conclude that the hypothesis of Terby, as well as that of Veeder, may be discarded and that Arrhenius' theory does not explain the facts.

I will simply give the figures for the days of beginning of the 60 most active storms observed at Greenwich. Expressed in per cent of the total areas occupied by sunspots these figures are for each tenth of the solar radius:

Solar longitude.	Tenth of the sun's radius.									
	1	2	3	4	5	6	7	8	9	10
	%	%	%	%	%	%	%	%	%	%
0°-180°	4.96	2.68	4.93	4.24	2.69	**11.05**	2.15	3.44	1.06	0.08
181°-360°	0.01	1.31	3.52	6.50	**12.85**	7.91	**12.00**	8.34	5.58	4.69

The prevailing positions of spots for the days of magnetic storms, are therefore such that we have to admit that the radiations producing the storms are restricted pencils of rays, deviated from the normal and propagated from the sun to the earth with a velocity similar to the velocity of light.

If this radiation consists of β rays, as has already been supposed by A. Brester and others, the deviation in particular cases will, perhaps, give some information on the fluctuations of the intensity of the magnetic field in sunspots.

In order to verify the assumption that we have really to deal with β rays I made some more calculations.[2]

One of the most characteristic properties of β rays being to produce the condensation of vapors, if the magnetic storms are due to β rays, we may evidently expect a correlation between rainfall and magnetic storms. The observations made in Batavia from 1886 to 1899 give, for the days of magnetic storms (190 in all) and for the days preceding and following these days, perfectly convincing figures.

The totals expressed in millimeters are:

−6	−5	−4	−3	−2	−1	0
933	*1195*	1075	735	1117	1120	*1450*
+1	+2	+3	+4	+5	+6	+7
933	913	838	*1034*	928	837	873

The secondary maxima observed 5 days before the date of the magnetic storms and 4 days afterwards may be considered as a confirmation of Loomis' observations.

The Greenwich data of 1882 to 1903 give a similar result for the secondary maxima, but for the days of magnetic storms rainfall in Greenwich is at its minimum.

But we may notice that Montigny observed in Brussels that the twinkling of the stars is more pronounced on the days of magnetic storms than before and after those days. This shows evidently that condensation would take place at Brussels or at Greenwich, just as at Batavia, if the atmospheric conditions were favorable.

This leads to the question whether magnetic storms may occur only under anticyclonic conditions prevailing in high latitudes? Or, taking into account the researches of Störmer and Birkeland, then only when the atmospheric conditions are favorable for the penetration of β rays to lower altitudes.

The consequence is that the rainfall data not only verify the β rays hypothesis but that other correlations with different orders of meteorological phenomena may also be expected.[2]

LOCAL WIND OF THE FOEHN TYPE NEAR SAN FRANCISCO BAY.

By BURTON M. VARNEY, Instructor in Geography.

[University of California, Berkeley, Cal., Nov. 15, 1917.]

Dynamic warming of air by descent from mountains into valleys or onto plains is a well-recognized meteorological phenomenon. It occurs notably in the Swiss valleys on the north side of the Alps, under the control of areas of low barometric pressure moving across central Europe. The [dry] chinook winds over the high plains of the western United States and Canada are of similar origin. A wind of the foehn type, produced in a somewhat similar fashion, though controlled rather by high pressures than by low, is occasionally felt at Berkeley, Cal., where the University of California maintains a meteorological station. This wind, blowing from the east or northeast, causes, if it lasts for more than a few hours, very dry atmospheric conditions at Berkeley, and in the summer time uncomfortably high temperatures. This is in strong contrast to the cool, rather moist westerly wind

[2] The reader's attention is here asked to Störmer's memoir in Journal of Terrestrial Magnetism for September, 1917, wherein Störmer shows that, as far as the production of the aurora is concerned, it is difficult to harmonize the facts with the hypothesis that the aurora is due to negatively charged particles (β rays).

A brief note on Brester's theory of the sun was published in the MONTHLY WEATHER REVIEW for October, 1917, p. 485.

Relations between sunspots and rainfall have been discussed in this REVIEW for February, 1907 (35:72), and July, 1907 (35:309).—C. A., jr.

conditions which hold for much of the year under the control of a local indraft of surface air through the Golden Gate and across San Francisco Bay.

The campus of the University of California lies at the foot of the Berkeley Hills, which overlook the bay. The instrumental exposures at the meteorological station range from 300 to 325 feet above sealevel. On the east rise the hills to altitudes of 1,500 to 1,900 feet within a mile and a half to 2 miles, and on the west a smoothly sloping plain falls away to the bay some two miles distant. The topography favors dynamic warming of air which crosses the hills from an easterly direction and is forced to descend the slopes toward the bay. Easterly winds are not common at Berkeley. For their occurrence, a dominant area of high barometric pressure over the Cordilleran region with gradients sloping westward and southwestward toward the Pacific, is necessary. Under these conditions, rarely in summer and occasionally in winter, the persistent westerly and southwesterly wind at Berkeley is fully reversed and an offshore wind produced. The length of time during which this reversal may hold is variable in the extreme, and depends on a delicate adjustment of atmospheric conditions the details of which are, as yet, too obscure for discussion.

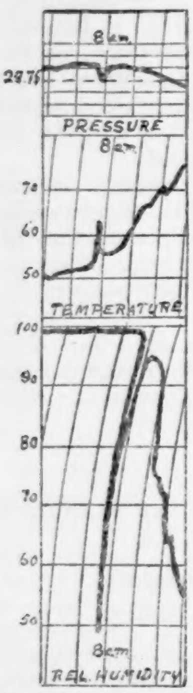

FIG. 1.—Copy of barogram, thermogram, and hygrogram recorded at University of California, Nov. 2, 1917, showing abrupt changes due to temporary prevalence of an easterly wind at Berkeley.

This easterly surface current, occurring at Berkeley more frequently in winter, apparently differs in its origin from an upper current occurring in the San Francisco Bay region in summer, and noted by McAdie as follows:[1]

> Kite experiments indicate that at the 1,000-meter (3,280-foot) level on summer afternoons there is a moderately strong flow of air from east to west. It would seem as if the heated air of the Great Valley, or some portion of it, moved seaward above the level of the incoming or eastward flow of the surface draught.

The surface current occurs chiefly when the continent has prevailingly high pressures as contrasted with the low pressures of the oceanic area, while the upper current occurs when the continent is prevailingly under low pressure and the oceanic area high pressure.

A striking example of a very short lived easterly wind occurred in the early forenoon of November 2, 1917. Atmospheric pressures over Nevada and Arizona on that morning were high (30.00 inches in central Nevada), and the winds over the California coast were mainly offshore and moderate. At San Francisco, however, the 5 a. m. [8 a. m. 75th meridian time] observation at the local office of the Weather Bureau indicated moderate westerly winds. At Berkeley up to about 7:30 a. m. the winds were also westerly and moderate. Between 7:30 a. m. and 8:00 a. m. the prevailing easterly wind dominating the Pacific slope overcame the westerly wind at Berkeley. The abrupt change in the atmospheric conditions is shown in the accompanying traces of the autographic records made at the meteorological station. (See fig. 1.) As a result of warmth of the descending air, in part dynamically produced, the temperature rose 12 degrees in less than that number of minutes. The pressure dropped nearly 0.10 inch when the relatively warm and therefore lighter air from the hills took the place of the cooler, heavier air from the ocean. The relative humidity dropped from very near the saturation point to less than 50 per cent so suddenly that the time occupied can not be judged from the trace. The easterly wind blew for something less than half an hour, and the recovery of all the curves was very rapid. The rapid diurnal rise of temperature and the fall of relative humidity, characteristic of fine weather at this station, would have begun at about the time when conditions were suddenly interrupted by the wind from the hills. There is evidence that this is the case, in the fact that both temperature and humidity curves returned, not to the values they represented before the interruption, but to values approximating those which would have obtained in the uninterrupted diurnal curve.

[1] *McAdie, A. G.:* The rainfall of California. Univ. Cal., Publ. geog., Feb. 19, 1914, 1: 145.

NEBRASKA HAILSTORM OF AUGUST 8, 1917.

By GEORGE A. LOVELAND, Meteorologist.

[Dated: Weather Bureau Office, Lincoln, Nebr., Nov. 20, 1917.]

During the spring and early summer local storms of greater or less severity may reasonably be expected in that portion of the United States lying east of the Rocky Mountains. Such storms consist of wind, rain, and sometimes hail.

Hail is a very interesting phenomenon in connection with these storms, though occasionally terrifying and destructive. From a study of the rather incomplete hail records of the Nebraska Section Center of the Weather Bureau, it is found that out of a possible 100 per cent hail probability during the four months, May, June, July, and August, 33 per cent of the hail would occur in June, 23 per cent in May and July each, and 21 per cent in August.

What is doubtless one of the most remarkable hailstorms on record is that which occurred in southeastern Nebraska on August 8, 1917—remarkable in the unusual length and breadth of the area covered, the great amount of damage done to crops and property, the large size of the individual hailstones, and the enormous quantity of hail that fell.

From reports of cooperative observers, conversations with citizens in the hail district, newspaper accounts of the storm, and from a personal visit by the writer three days later to a portion of the devastated district, the course and duration of the storm has been quite accurately defined (see fig. 1), it has been possible to make a somewhat correct estimate of the damage done, and many interesting and unusual facts have been brought out.

The storm traveled from a point in Merrick County north of Central City to the Kansas line south of Wymore, in Gage County, a distance of approximately 92 miles in length, and over a width of 4, 8, or even 12 miles, as variously reported. In hailstorms recorded in the past the length is usually less than 50 miles and the width but 1 or 2 miles.

The writer has been unable to obtain any actual measurements of the hailstones in this storm, but the common description was "as large as hen's eggs," or "as big as your fist," or, most common of all, "the size of baseballs." In one house in York the hail blew in through a wire screen, a glass windowpane, and a thick cloth shade which happened to be down, and an hour later the owner of the house found a hailstone on the bed, and according to her testimony it was then the

size of a hen's egg, and around it was a good-sized damp spot from the melted ice. The marks on the sides of houses showed the large size of the hail, and were so close together there was not room to put one's fingers between them. High up in a window on the north side of the Burlington Railway station at York was a smooth, round hole about 2 inches in diameter. As this was under the eaves, which projected 4 or 5 feet over the sidewalk, the wind must have come rather horizontally and with great force to cut such a neat, round hole.

The quantity of hail which fell was enormous. Observers say that during the storm they were not able to see 10 yards. Drifts of hail 3 to 5 feet high were found in protected places. Photographs taken shortly afterwards show the ground white with hail like a 1 or 2 inch fall of snow in winter. In an orchard near Exeter hailstones and apples which had been knocked off lay on the ground thickly, and were practically the same size, so that in the photograph it is difficult to distinguish which are apples and which hailstones. At Swanton, the day after the storm, a drift 1 foot high was piled up against a building; and at Bradshaw hail was still visible on Friday, two days after the storm.

According to the testimony of the people the wind velocity varied in different localities. Around Polk there was a light wind, while at York the velocity was considerable. Large hailstones were blown through the north windows of the hotel there, and some rolled along the second-floor corridor a distance of 70 feet and thence down the stairs to the office below. In private houses the hail was blown from one side clear through to the other. At Exeter the wind was still more severe. The tops of trees were badly damaged, the ground being strewn with branches; roofs were blown off, and windmills and smaller farm buildings tipped over.

The property loss was considerable. Throughout the hail-beaten district windows on the north side of buildings were shattered; many costly art-glass windows in the churches were destroyed, and business blocks, hotels, private residences, and farmhouses were more or less damaged by broken glass; skylights, tin roofs, and shingles were everywhere injured, and in many places the siding of houses and window casings were cracked and split as if hit with a sledge hammer. In York the tile roof of the new Federal building was so badly shattered that three sides of it had to be relaid. In Exeter and Friend the windows were broken and siding injured on the west side of buildings as well as on the north, for in that section the wind came from the west and northwest.

Hundreds of chickens were killed; young pigs and calves were fatally injured; horses and cattle in pasture away from shelter were so pounded and bruised that they were covered with blood and huge lumps; rabbits were killed by the score in the fields, and one farmer picked up 400 dead grackles—crow blackbirds—in a space about 300 by 300 feet.

Fruit and shade trees were badly stripped of leaves and fruit, and even the branches had the bark torn off in places; garden truck was completely destroyed, and sweet corn was completely ruined. Fodder corn, cane, and millet were badly damaged, and prairie hay land was stripped of its grass, which was washed down and piled against the fences.

Fortunately all small grain had been harvested, but the corn crop over the entire area of the storm—225,000 acres of corn affected—was probably damaged 50 per cent.

The writer passed through a portion of the devastated region the latter part of October, and learned that the corn ears that were pounded by the hail did not develop enough to pay for the trouble of husking. Some farmers had turned their stock in to eat what was left in the fields, and others had cut it up for ensilage and stored it away in silos. Some people replanted their gardens, and successfully raised a few vegetables before the killing frost of October 8. Residences all through the devastated district had been reshingled and newly painted; downspouts and gutters had been mended; glass replaced, and the dead leaves and fallen branches cleared away, so that but little trace of the terrible storm was left.

PRECEDING WEATHER CONDITIONS.

A study of the weather conditions preceding this hailstorm shows that a cyclonic area of considerable energy passed eastward to Iowa on the night of August 6–7, and was accompanied by substantial rains in Kansas, eastern Nebraska, Iowa, and Minnesota. Two minor disturbances followed this LOW—one centered in the northern and one in the southern part of the United States. On the morning of the 8th these disturbances were connected by a trough of moderately low pressure, which extended from New Mexico northeastward across western Kansas and central Nebraska to Minnesota. An area of high pressure of considerable energy, 30.4 inches, moved rapidly southeastward from the extreme north along the eastern slope of the Rocky Mountains, and on the morning of the 8th was centered in Montana, but extended over Wyoming, the Dakotas, and northwestern Nebraska. This HIGH continued its course southeastward, and on the morning of the 9th had extended over most of Nebraska, Kansas, Iowa, and Minnesota, with its center at 30.4 inches in western South Dakota.

This hailstorm appears not to have been of the usual type. The temperature was not specially high at the earth's surface; on the contrary the maximum temperatures on the 8th in the region where the hail occurred and in all of eastern Nebraska, were slightly below normal. They ran as follows: York, 83°F.; Pawnee City, 85°; Falls City, 88°; Hebron, 85°; Fairmont, 80°; and Grand Island, 86°. The average maximum temperature at Lincoln on that date is 87°, and may fairly be taken as an index to the average maximum temperature for the region under discussion.

Many people noticed the unusual appearance of the clouds before the hail began. One observer in York described them by saying that there was a greenish cloud in the southwest and another in the northwest, greenish also, but much darker, and that they seemed to be coming together, while in the center were masses of smaller lighter clouds rolling over and over and tumbling about with great violence. She spoke of the queer roar and crackling which preceded the hail, "like marbles knocking together in the sky." Then followed the terrific roar of the hail itself as it fell upon the tin roof of the store. Voices could not be heard and the noise of the bombardment was beyond description. An observer at Friend, and many elsewhere, mentioned the greenish clouds and reported that before the storm it was quite warm, with a south-southwest wind; that there was just a little hail at first; then a lull, after which the wind turned suddenly to the north and the hail came with a rush. The largest-

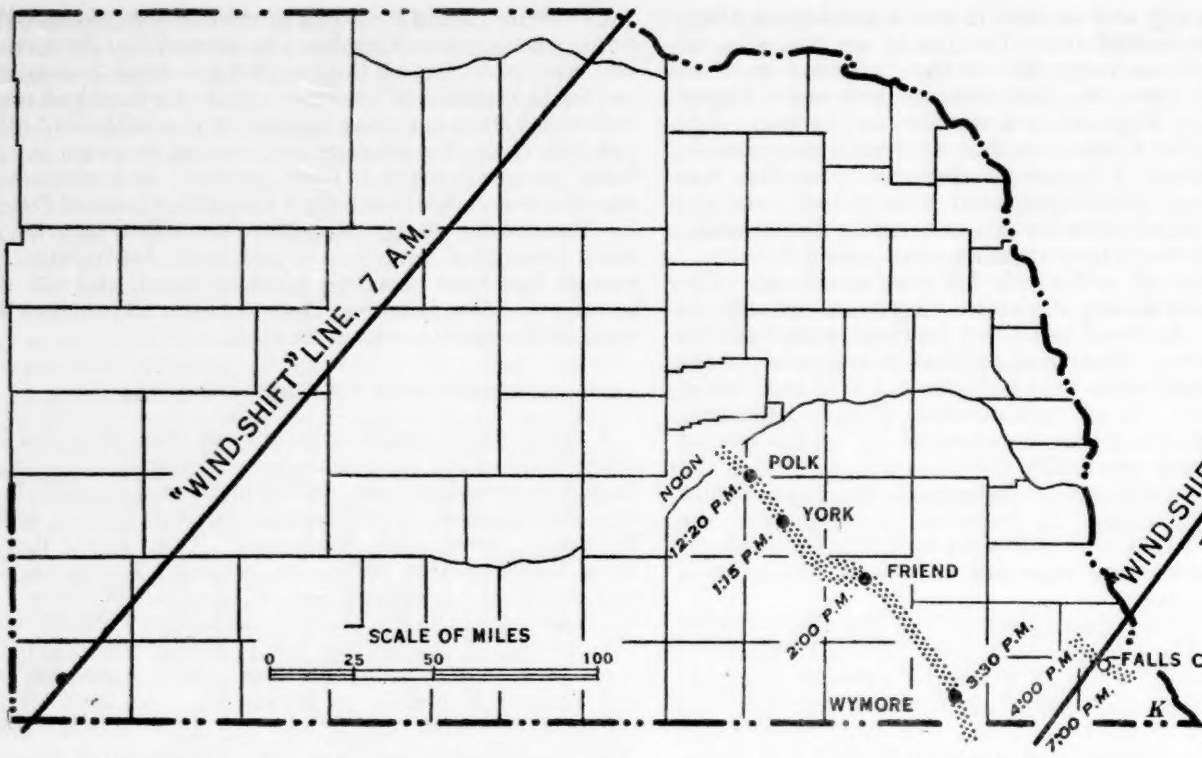

FIG. 1.—Map of eastern Nebraska, showing path of the destructive hailstorm of Aug. 8, 1917, with times of arrival at successive points.

sized hail fell immediately after the change in the wind, followed by smaller hail which fell in enormous quantities for 10 minutes or 15 minutes. Some rain accompanied the hail and continued falling for some time after the hail stopped. The total precipitation exceeded 1.00 inch (water) over most of the storm area.

The storm path is shown in figure 1 from the point of first occurrence in Merrick County, north of Central City, about noon, southeastward, progressing at the rate of about 25 miles an hour, until it reached northern Kansas at about 4 p. m. The writer believes that as the trough of low pressure shown on the weather map of August 8, 7 a. m. (Central Time), passed eastward, the hail came with the shift of wind upon the advent of the energetic HIGH closely following the trough of moderately low pressure. This trough extended across the State from southwest to northeast and the "wind-shift" line reached the northernmost points of the hail region first. The hail was propagated southward along the advancing line of contact between the cool and the warm air currents which was revealed by the violent commotion in the clouds noticed by observers. These conditions moved eastward with the general cyclonic area of which they were a part, resulting in the southeasterly trend of the hail path, and were not, as many people supposed, a definite cloud mass or small cyclonic area eight or ten miles wide moving in a southeasterly direction.

It is common for summer thunderstorms in Nebraska to occur along the "wind-shift" line in a trough of low pressure as outlined for this hailstorm. As this trough passed over Nebraska the rainfall was light, except in connection with the hailstorms. Similar conditions developed in other parts of this trough. Small severe hailstorms were reported in Kansas, and one 13 miles in length in Nemaha and Richardson Counties, Nebr. The latter reached Falls City at 7 p. m. just as the trough of low pressure passed, and the wind shifted to the north on the advent of the HIGH.

VAPOR PRESSURE OF ICE.[1]

By S. WEBER.

(*Reprinted from* Science Abstracts, Sect. A, Sept. 29, 1917, §978.)

The object of these experiments was to investigate the vapor pressure of ice at very low temperatures and to obtain, if possible, new foundations for the truth of formulas showing the dependence of vapor pressure on temperature. The principal difficulty in such measurements is the fact that at very low temperatures the vapor pressure becomes extremely small, e. g.:

Temperature, °*C.*	Vapor pressure of ice. *mm. of Hg.*
0	4.579
−25	0.480
−63	0.003
−98	0.000015

and previous results are not to be relied on below 60° C. [−60° C?.] A statistical method was adopted, the pressure being measured by an absolute manometer, which was sensitive to a difference of pressure of 0.001 dyne/cm², and a Wollaston hot-wire manometer. Special care was taken to have the necessary correction for thermomolecular pressure as small as possible. Control measurements were made with a mercury manometer, temperatures being registered by a platinum-resistance thermometer. The water used was obtained partly by repeated distillation, partly by synthesis.

Experiments were conducted at temperatures from −22° to −193° C. The results were placed in a number of tables and are found to agree very well with the vapor-pressure formula due to Nernst:

$$\log p(\text{mm.Hg}) = -2611.7/T + 1.75 \log T - 0.00210\,T + 6.5343.$$

—*T.B*[*arratt*].

[1] Kongl. danske vidensk. selskabs forh., 1916, p. 459. Ztschr. f. Instrumentenk., Beibl. Mar. 1, 1917, 5:41-43.

THE ARITHMETIC MEAN AND THE "MIDDLE" VALUE OF CERTAIN METEOROLOGICAL OBSERVATIONS.[1]

By L. Becker.

[*Reprinted from* Science Abstracts, Sect. A, Sept. 29, 1917, §868.]

The maximum daily temperatures observed at Glasgow Observatory over a period of 48 years have been taken, and the distribution of these about their "middle" value calculated for each day of the year. It is found that the distribution is not normal, but that from March to October the extremes of high temperature lie much farther from the middle value than the extremes of low temperature, the scattering in September extending 10 degrees (F) farther on the positive side than on the negative. In the winter, on the contrary, the scattering extends 8 degrees farther on the negative than on the positive. When all the days of the year are taken together, this lack of symmetry disappears. The difference "Middle temperature − Mean temperature" is found to vary from +0.5 degree in February to −0.75 degree in August.—*J. S. Di[nes]*.

[1] Proc., Roy. soc. Edinburgh, 1916-1917, **37**: 210-214.

NEW ZEALAND STANDARD TIME.

[*Reprinted from* Nature, London, Nov. 1, 1917, **100**: 174.]

The present arrangement whereby the standard civil time in New Zealand differs from Greenwich mean time by $11^h\ 30^m$ was adopted on the suggestion of Sir James Hector in 1868, before the general system of zone time was introduced. The council of the Wellington Philosophical Society has recently taken the matter into consideration, and has resolved to urge upon the Government the desirability of making New Zealand time exactly 12 hours in advance of Greenwich. New Zealand is so happily situated that it would be possible by this simple alteration to secure the advantages of a time system moderately in advance of solar time, and to bring the time into conformity with the international arrangement. As there is no extreme variation in the length of the day at different seasons, it is proposed to put the clock forward by half an hour, once for all.

SECTION III.—FORECASTS.

FORECASTS AND WARNINGS FOR NOVEMBER, 1917.

By H. C. FRANKENFIELD, Supervising Forecaster.

[Dated: Weather Bureau, Washington, D. C., Dec. 8, 1917.]

GENERAL PRESSURE DISTRIBUTION OVER THE NORTHERN HEMISPHERE, EXCEPT EUROPE AND INTERIOR ASIA.

Over the North Pacific Ocean, as indicated by the reports from Midway and Honolulu, pressure was generally high during the first two weeks of November, 1917, with a marked crest over the central portion from the 6th to the 8th, inclusive. After the 14th there were alternate periods of moderately low and high pressure, with a fair depression from the 16th to the 18th, inclusive.

Over the Aleutian Islands, as indicated by the reports from Dutch Harbor, pressure was generally high throughout the month, with a pronounced maximum on the 29th. There was also another fairly marked crest on the 11th.

Over Alaska pressure was generally low during the first half of the month, with the exception of a short period of high pressure over the interior districts on the 10th. During the second half of the month there were successive periods of well defined high and low pressure areas, each of about 3 days' duration, with very low pressure over southeastern Alaska on the 28th and equally marked high pressure over the interior on the 30th, the latter the eastward extension of the Aleutian high area above mentioned.

Over the western portion of the United States moderately high pressure prevailed generally during the first three weeks of the month, after which pressure was low for three days followed by a recovery to above normal conditions during the next 4 or 5 days, with another fall during the closing days of the month. The first of these low areas apparently originated over the section east of Alaska and moved southeastward with rapidly increasing intensity and by the 22d, when it had reached the upper Lakes Region, it had developed into a storm of great intensity attended by strong gales and snow. After leaving the upper Lakes the storm continued to move southeastward with rapidly decreasing intensity, although the general depression extended in marked form as far south as northern Florida. Aside from this great general depression barometric conditions were not unusual over the eastern half of the country, moderately high pressure prevailing during the first decade of the month and nearly normal conditions during the remaining days until the 25th, when a rise set in that continued for about three days.

Over the North Atlantic Ocean low pressure predominated, with a pronounced depression that moved northward, rapidly increasing in intensity and passing off the New England coast on the 10th with the proportions of a severe storm.

STORM WARNINGS.

During the first week of the month low pressure prevailed over the Caribbean Sea, and on the morning of the 4th a high-pressure area of great magnitude covered the United States and Canada with a crest of 30.7 inches over Ontario. The resulting gradient indicated the occurrence of fresh to strong north and northeast winds along the Atlantic coast, and small-craft warnings were accordingly ordered from Norfolk, Va., to Nantucket, Mass. Moderately strong winds occurred.

On the morning of the 18th, with rapidly rising pressure following a moderate disturbance, small-craft warnings for moderately strong northwest winds were ordered at all Lake stations; and the winds occurred as forecast. At 8 p. m. of the 18th with the disturbance over new Brunswick, warnings of strong northwest winds with much cooler weather were ordered at New York City and Sandy Hook, N. J. Moderate gales occurred both in this vicinity and locally along the New England coast.

On the morning of the 19th a disturbance from the Canadian Northwest was central north of Manitoba with an eastward movement, and at 2:30 p. m. advisory warnings of fresh to moderately strong southwest and west winds were sent to stations on Lake Superior and northern Lakes Michigan and Huron. This disturbance did not develop further, and no winds of consequence occurred. On the following morning there was a very moderate disturbance over Louisiana with a northeastward movement, and at 2:15 p. m. advisory warnings were issued for moderately strong northeast and north winds on the North Carolina and Virginia coasts. There were fresh winds on the North Carolina, but none on the Virginia coast.

On the morning of the 21st another Canadian Northwest disturbance was central over western Lake Superior, and northwest warnings were ordered at 10 a. m. for western Lake Superior, and southwest warnings for eastern Lake Superior, northern and central Lake Michigan and northern Lake Huron. This storm continued to move slowly southeastward with steadily increasing intensity, and at 4:30 p. m. northwest storm warnings were ordered for the balance of Lake Michigan, and southwest warnings on southern Lake Huron and Lakes Erie and Ontario. This storm proved to be the most severe one of the month, and on the evening of the 21st it was central over southern Michigan, with a barometer reading of 29.16 inches. On the following morning the storm center was over the northwestern shore of Lake Erie and fresh to strong gales were blowing over Lakes Superior, Michigan, and Huron. At Middle Island, Mich., the wind velocity was 66 miles an hour from the northeast, with heavy snow falling. Warnings that were about to expire were continued, and at noon whole gale warnings were ordered from Alpena, Mich., to Erie, Pa., and advices issued that it was dangerous for vessels to proceed on Lakes Huron and Erie. At 3:30 p. m. the warnings on eastern Lake Erie and Lake Ontario were changed to northwest. The gales occurred as forecast, except on Lake Ontario and eastern Lake Erie, which were not greatly affected, as the storm, after crossing Lake Erie, continued east-southeastward with rapidly decreasing intensity, a secondary disturbance having developed during the afternoon of the 22d over northern New Jersey. Notwithstanding the severity of the storm on the Upper Lakes, no marine casualties were reported.

While the above storm was moving southeastward, the moderate southern disturbance was moving northeastward and was just off the North Carolina coast on the

morning of the 21st. There was some prospect of increasing development with the northeastward movement, and advisory warnings to this effect were sent at 3 p. m. to North Atlantic and southern New England coast stations. The disturbance deepened as expected, and owing to the approach of the Lakes storm orders were issued at 9:30 p. m. to display southwest storm warnings at 8 a. m. of the 22d from Delaware Breakwater, Del., to Portland, Me. The winds were expected to increase from south and southwest and to shift to northwest by the 23d, reaching gale force. During the 22d pressure continued to fall rapidly throughout the East and South, reaching 29.48 inches at Savannah, Ga., at 1 p. m.; accordingly at 4 p. m. northwest storm warnings were ordered from Reedy Island, Del., to Jacksonville. Orders were also issued to change the warnings to northwest at 8 a. m. of the 23d from Delaware Breakwater to Portland, and to hoist northwest warnings east of Portland. However, by the morning of the 23d the storm had greatly decreased in intensity and all warnings were lowered.

No other storm warnings were issued during the month, except for the Canal Zone. On the morning of the 3d marked high pressure prevailed over the South and low pressure over the Caribbean, and warnings for strong northerly winds during the next two days were sent to the Canal Zone. This warning was justified by the occurrence of strong northerly winds that reached a maximum of 40 miles an hour from the northwest at 5:30 a. m. of the 5th. Mr. R. Z. Kirkpatrick, Chief Hydrographer of the Panama Canal, reported as follows regarding this storm:

A high wind accompanied by occasional showers prevailed over the Atlantic side during the day and night of the 4th and the morning of the 5th. The wind averaged 23 miles per hour for the 23-hour period from 9:30 a. m. of the 4th to 8:30 a. m. of the 5th. The storm started with the wind in the southwest, gradually shifting to the northwest by 4:30 a. m. of the 5th and obtaining a maximum velocity of 40 miles from the northwest at 5:30 a. m. of the 5th. At 8:30 a. m. of the 5th the wind velocity had dropped to 20 miles an hour from the northwest. The sea and the bay were rather rough and a heavy swell was in evidence outside the breakwater, but no damage has been reported. During the period of the storm the temperature fluctuated between 80° and 73°.

The following table will give a general idea of the rainfall over the Isthmus during the period of the storm.

Canal Zone rainfall during storm of Nov. 4–5, 1917.

Stations.	Rainfall.		
	Amounts.	Began.	Ended.
	Inches.		
Colon	2.73	Noon, 4th	4 a. m., 5th.
Gatun	2.30	Noon, 4th	6 a. m., 5th.
Monte Lirio	2.95		
Frijoles	1.46		
Vigia	2.21	8:45 a. m., 4th	4 a. m., 5th.
Alhajuela	2.15	9 a. m., 4th	4 a. m., 5th.
Juan Mina	2.67		
Gamboa	1.54	9:15 a. m., 4th	11 a. m., 5th.
Empire	0.99		
Culebra	1.06		
Rio Grande	0.86		
Pedro Miguel	0.72	12:30 a. m., 5th	11 a. m., 5th.
Balboa Heights	0.58		

No damage was done to Canal structures. However, the schooner *Blanche E. Pendleton*, which was swept ashore in the outer harbor of Colon during the norther of February 8–9, 1915, and has lain there since, broke up during the night of November 5. Also an 18-foot cayuca, carrying 12 persons, was upset in Gatun Lake and 6 persons drowned. The wind started at Colon from the west, later veering to the northwest. The waves overtopped the West Breakwater for spaces of 600 feet at times.

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On the morning of the 24th there was a more moderate high area central over Arkansas and Louisiana with strong northwest winds over northwestern Cuba and the Yucatan Channel, and warnings of strong north winds were again sent to the Canal Zone. These occurred as forecast, but they set in earlier than had been anticipated, although the maximum wind of 42 miles an hour from the northwest did not occur until 7:28 p. m. of the 25th. Mr. Kirkpatrick has written as follows regarding this storm:

The stormy period from November 15 to 25, inclusive, reached its climax on the 24th and 25th in an unusually high wind of the "norther" type. During the fore part of this period the winds were moderate and mostly from the west and southwest. By the 22d the wind had shifted to northwest and continued to blow from that direction with occasional changes to north. By 3 a. m. of the 24th it had increased in velocity to 25 miles per hour and continued to average from 25 to 34 miles per hour till 8 a. m. of the 25th, when it moderated and by afternoon had fallen below 20 miles per hour. For the 17-hour period from 1 p. m. the 24th to 6 a. m. the 25th the wind averaged slightly over 31 miles per hour with a maximum velocity for a period of 5 minutes of 42 miles from the northwest at 7:28 p. m. This has been exceeded only once in the last 10 years.

The storm was accompanied by light showers. The barometer averaged 0.08 inch above normal and the reading at 8 a. m. the 24th, 29.975 inches, is with one exception the highest ever recorded in November. The temperature was subject to sudden changes [and ranged] from 79° to 72°. A heavy swell was running outside the harbor and the water in the bay was very rough and choppy.

No material damage was reported.

On the morning of November 26, although high pressure conditions over the eastern half of the United States and the Gulf of Mexico were more strongly marked than on the 24th, a warning of strong north and northeast winds for the Canal Zone apparently failed of full local verification, but nevertheless strong northeast winds were reported a few hundred miles to the east-northeastward on the morning of the 28th.

Under date of December 1, 1917, Mr. Kirkpatrick wrote as follows regarding this warning:

During this period the wind blew continually from the north and northeast, the hourly amounts varying from 2 to 23 miles. The wind was light to moderate during the night, reaching its greatest velocity in the middle of the day. On the 27th it averaged 17 miles from 11 a. m. to 5 p. m., and on the 28 the sea was reported unusually rough at the entrance to the harbor.

There were 1.54 inches of rain on the 27th and 0.23 inch on the 28th.

FROST WARNINGS.

November opened with low temperatures prevailing throughout the South, and frost warnings were issued on the 1st, 2d, 3d, and 6th. Those of the 3d included northern Florida, where the minimum temperatures on the following morning ranged from 38° to 44° with clear weather. As the cold weather continued, no further warnings were sent for the local frosts that occurred during the ensuing 7 days north of Florida.

On the morning of the 12th, with a moderate disturbance over Alabama and high pressure closely following, frosts were forecast for the morning of the 13th over northern Alabama and interior Mississippi; but the weather remained cloudy. On the morning of the 15th pressure was again high over the Gulf States and the Central Valleys, and frosts were forecast for the morning of the 16th throughout the South as far as northern Florida. The warnings were repeated on the following morning and frosts appear to have occurred quite generally as had been forecast.

On the morning of the 23d, following the Lakes storm, frost warnings were sent to the Carolinas and Georgia;

but subsequent events showed that they should have been sent generally throughout the South, as heavy frost was reported on the morning of the 24th over northern Florida and temperatures below freezing in the eastern Gulf States.

General frost or freezing-temperature warnings for the South were sent out on the 24th and 25th, the frost being expected to extend into central Florida on the morning of the 25th and as far south as the 26th parallel on the morning of the 26th. These warnings were fully verified, light frost occurring in Florida on the morning of the 25th to a short distance below the 26th parallel.

"NORTHERS" OF THE CANAL ZONE.

The constantly increasing magnitude and importance of traffic through the Panama Canal has lent an additional interest and value to the meteorological conditions of that vicinity, and among the most important of these are the strong northwest to northeast winds that blow at times from November to April. These continue from one to as many as eight days, and frequently cause considerable damage to shipping, dock structures, etc. These "northers" are not by any means confined to the locality of Panama, but cover the western Caribbean, western Cuba, the Gulf of Mexico, the eastern coast of Mexico, and the coasts of the Central American Republics. The literature on the subject is quite extensive, the earliest contribution probably having been that of Redfield, in the American Journal of Science for 1844 (second series, vol. 1). In his discussion of the question Redfield treated principally the "northers" that occurred on the Mexican coast following the passage of West Indian hurricanes. They occur more often, however, without than with the passage of hurricanes, although the general pressure distribution over large areas is mainly of the same character. The most recent contribution on the subject is an unpublished manuscript by Mr. George J. Bentley, observer, Weather Bureau, who was formerly connected with the Hydrographic and Meteorological section of the Panama Canal. In his paper Mr. Bentley makes a proper differentiation between "northers" and "trade winds," the former being fresh to strong gusty and squally, from northwest to northeast and accompanied by intermittent rainfall, while the latter are more moderate, steady, and very constant winds from the northeast and seldom accompanied by rainfall. Quite recently Mr. R. Z. Kirkpatrick, chief hydrographer of the Canal Zone, submitted a memorandum on these "northers." This memorandum contained much valuable information of a historical character and it is therefore reproduced virtually in its entirety.

Historical notes on northers.—The following memorandum on "northers" was prepared from all data both French and American which were available. Information on "northers" prior to American occupation is taken for the most part from a report of Mr. Duboc to the director of French works in July, 1881.

The only storms of wide extent that visit the Isthmus are the so-called "northers" that occasionally reach as far south as Colon during the period from November to April, the season of the northerly trade winds. They are occasioned by an anticyclonic or high-pressure area over the Gulf and West Indies, there being a strong steady blow from this region of high barometric pressure toward the equatorial belt of low pressure. The principal damage to shipping interests results from the heavy swell and high waves that accompany these "northers" and not from any extremely high maximum wind velocities. The barometer does not indicate their approach and they come suddenly, attaining their full violence shortly after their appearance. There is, however, ordinarily a considerable rise in pressure accompanying or following the passage of these storms.

The following table gives a list of "northers," the date of occurrence, direction of the wind, together with remarks as to the damage done by the storms.

List of "northers" from French records for the Canal Zone.

Year.	Month.	Direction of wind.	Vessels wrecked.	Remarks.
1857..	November...	nnw.....	7	Much damage to wharves.
1861..	Oct. 22.......	n.........	3	
1865..	October......	sw.......	....	Lasted 6 hours; damage, $300,000.
1872..	February....	nnw.....	5	Wharves damaged.
1873..	Jan. 18-19....	nnw.....	6	Sea furious. Wharves 5 and 6 partly destroyed; 2 vessels damaged at wharves.
1878..	Dec. 8.......	nnw.....	4	Royal Mail steamer *Para* resisted with 2 anchors and 90 fathoms of chain, under strong steam.
1879..	Nov. 21-24...	n.........	4	Wharves 4 and 6 damaged.

The following is an extract from the report of Mr. Duboc:

> The sailors of Colon are of one accord in affirming that a "norther" may occur every year. However, they are not generally to be expected more than once in two years. The "northers" of 1878 and 1879 were both very strong, while, on the contrary, that of 1880 was nearly imperceptible (February), but in November or December, 1881, there was a veritable tempest.

The above are all the available data of the "northers" of 1880 and 1881.

The following table gives other "northers" of which we have knowledge, together with dates and remarks:

Year.	Month.	Remarks.
1885	Dec. 2-6..........................	14 vessels said to have been stranded.
1905	Jan. 26-27........................	No damage reported.
1906	December.........................	5 days' duration, last week in December.

The record of "northers" between 1881 and 1906 is very meager, and it is hardly likely that those listed above were all that occurred.

In the table following are listed those storms in which the wind averaged 18 or more miles an hour for a period of at least 24 hours, with a maximum velocity exceeding 25 miles an hour. This data is taken from Cristobal and Colon records from December, 1907, to October, 1917. The storms listed below can not all be considered as "northers" in the true sense of the word, although they are all a direct result of the interchange of air which takes place between an area of high barometric pressure over the Gulf and West Indies and the equatorial belt of low atmospheric pressure.

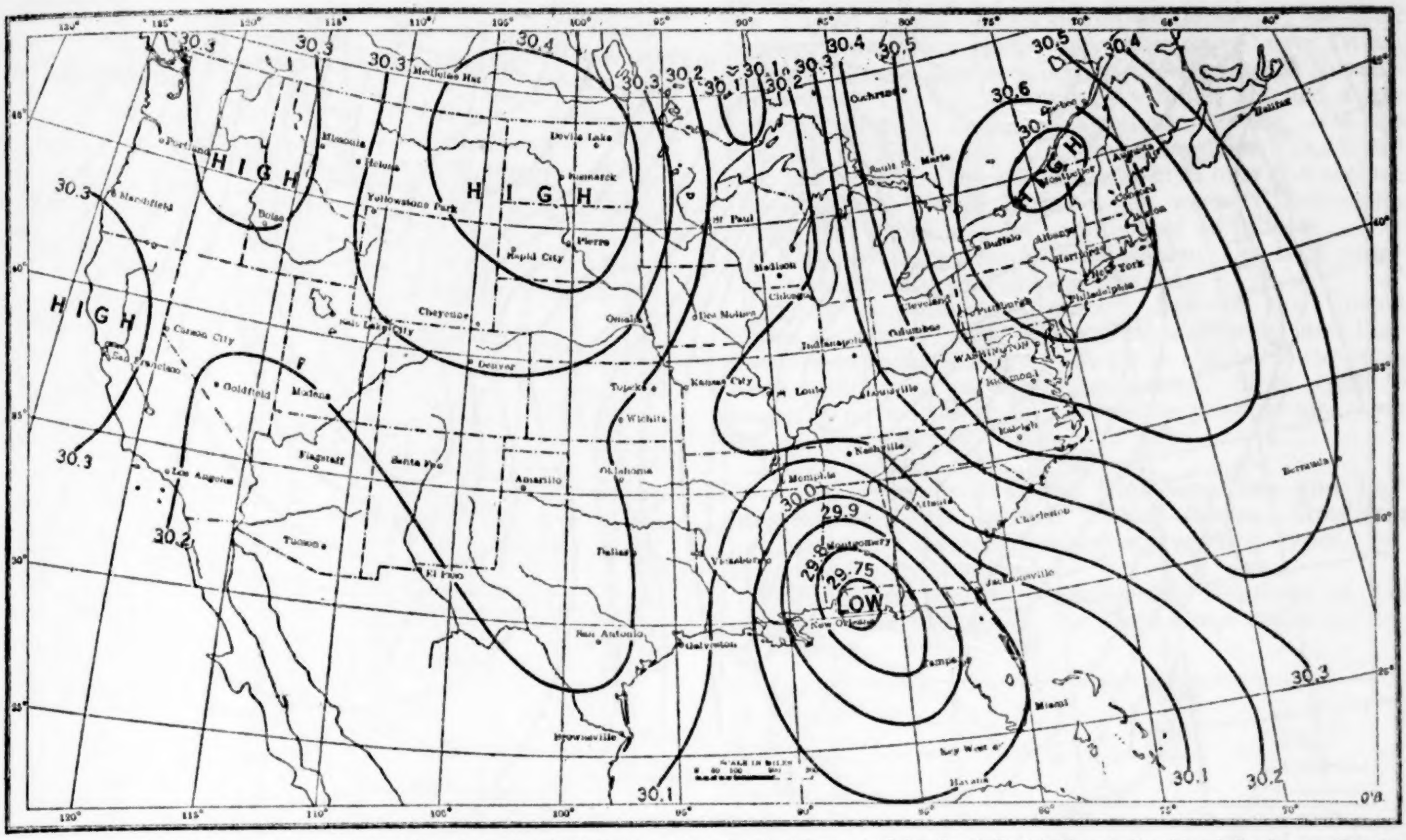

FIG. 1.—Pressure distribution on Feb. 11, 1910, preceding the norther of Feb. 13-15, 1910, in the Canal Zone. At Colon the wind attained a velocity of 36 mis./hr. from northwest.

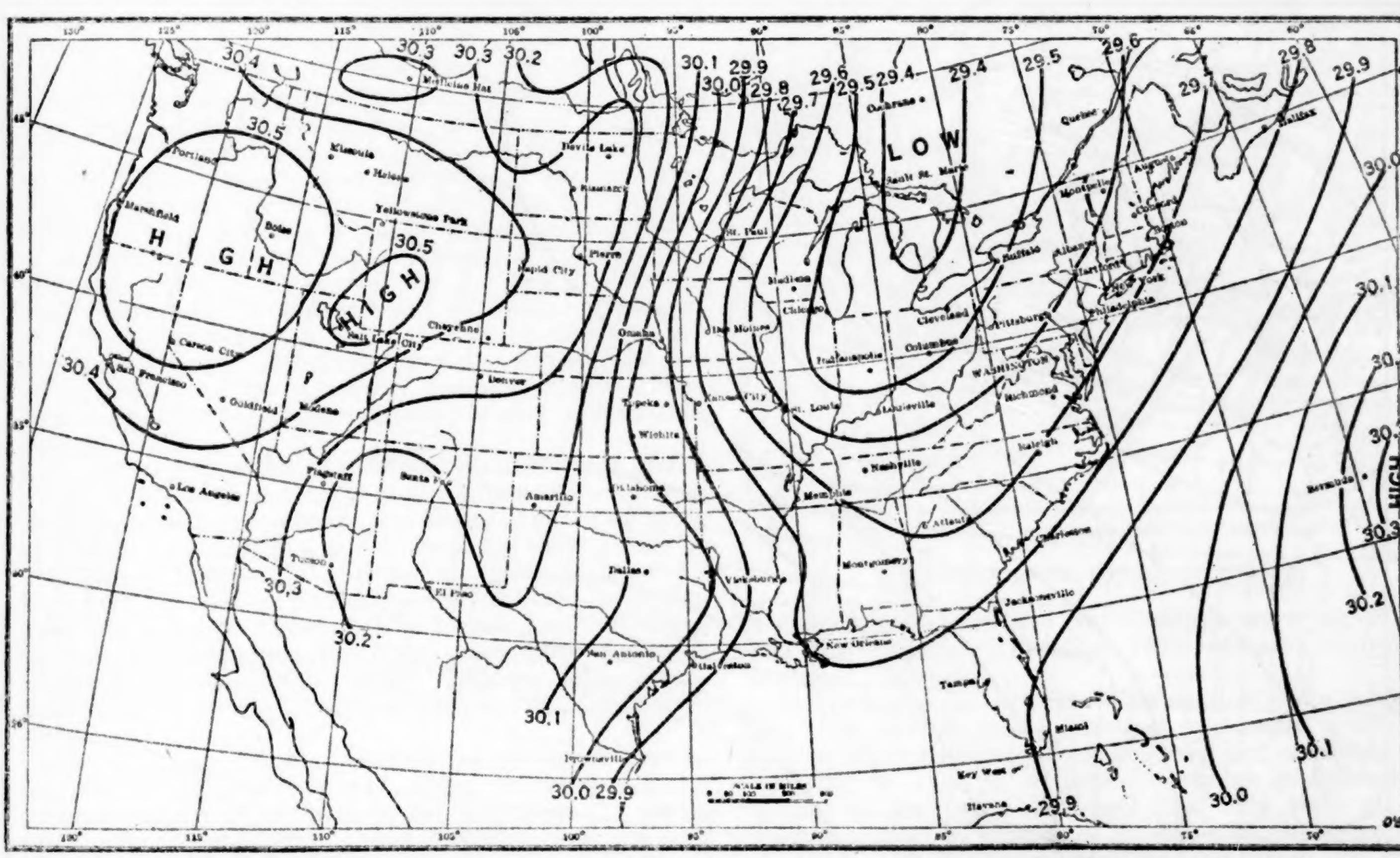

FIG. 2.—Pressure distribution on Mar. 15, 1913, preceding the norther of Mar. 17-19, 1913, in the Canal Zone. At Colon the wind attained a velocity of 36 mis./hr. from northeast.

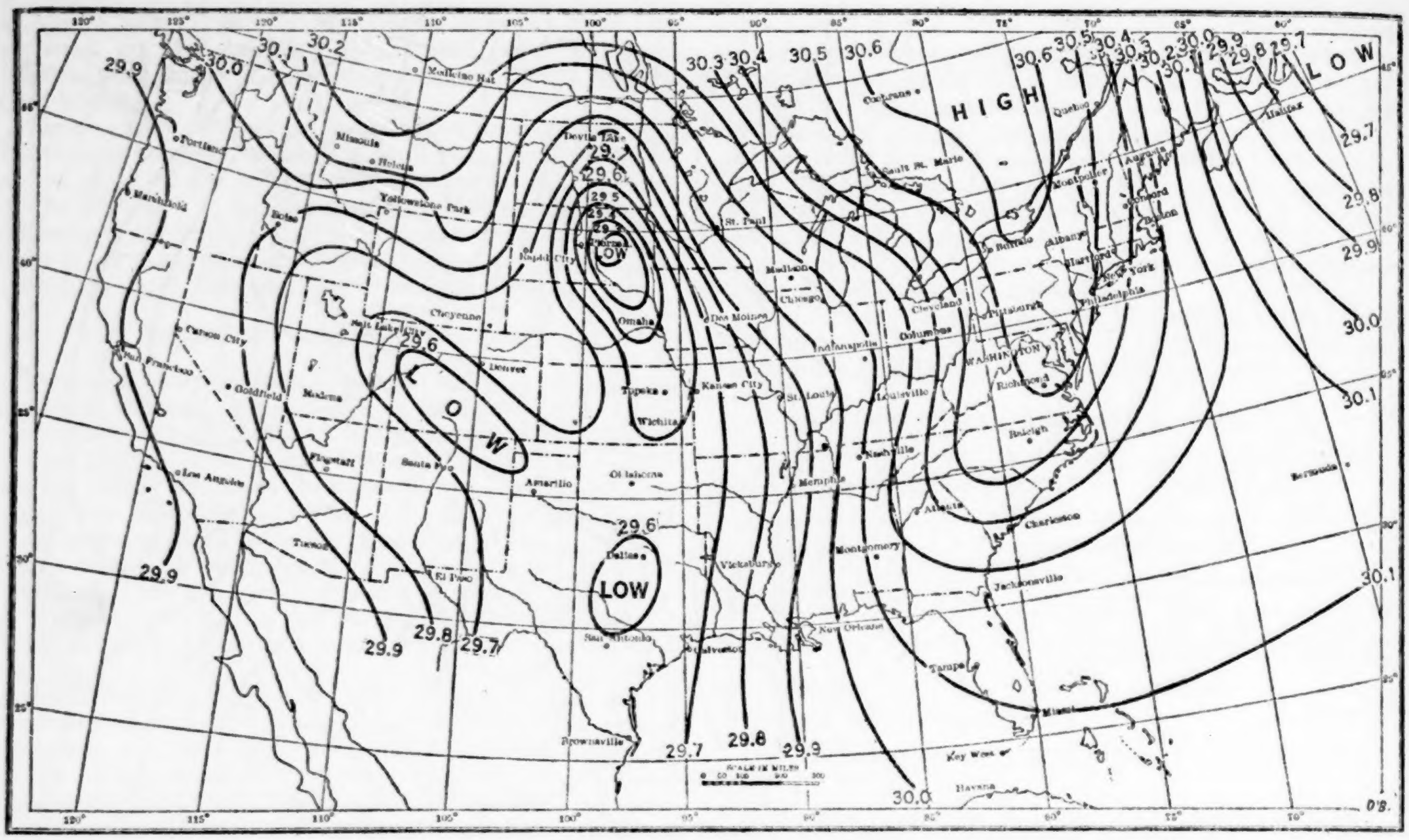

FIG. 3.—Pressure distribution on Dec. 26, 1916, preceding the norther of Dec. 28, 1916–Jan. 3, 1917, in the Canal Zone. At Colon the wind attained a velocity of 33 mis./hr. from northwest.

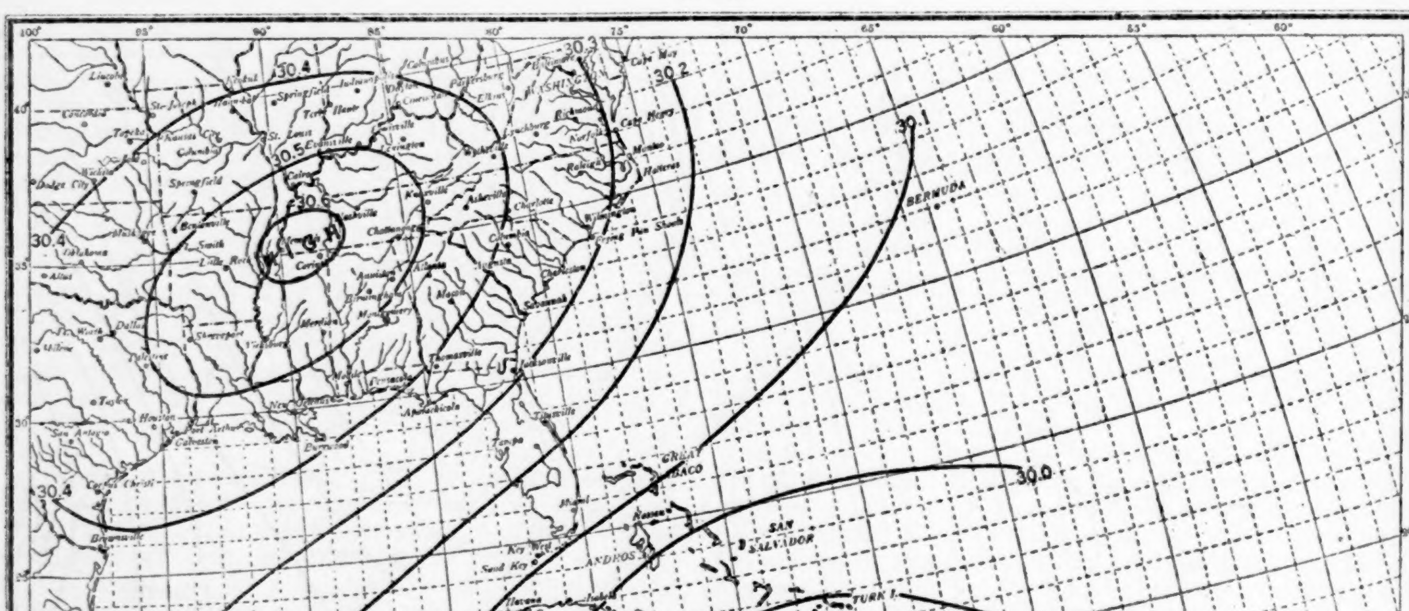

FIG. 4.—Pressure distribution on Nov. 3, 1917, preceding the norther of Nov. 4–5, 1917, in the Canal Zone. At Colon the wind attained a velocity of 40 mis./hr. from northwest.

Dates (inclusive).	Maximum wind velocity.		Dates (inclusive).	Maximum wind velocity.	
	Miles per hour.	Direction.		Miles per hour.	Direction.
Dec. 25-28, 1907	28	ne.	Feb. 9-14, 1915	39	n.
Dec. 31, 1907-Jan. 3, 1908	27	ne.	Feb. 18-19, 1915	34	n.
Jan. 14-15, 1908	31	ne.	Feb. 24-27, 1915	29	ne.
Feb. 2-4, 1908	28	ne.	Mar. 2-3, 1915	30	ne.
Feb. 20-22, 1908	31	ne.	Mar. 12-13, 1915	30	ne.
Mar. 6-12, 1908	29	ne.	Mar. 24-26, 1915	32	ne.
Apr. 4-10, 1908	32	ne.	Apr. 3-6, 1915	46	n.
			Dec. 13-14, 1915	30	ne.
Jan. 8-9, 1909	31	n.	Dec. 31, 1915-Jan. 1, 1916	31	ne.
Jan. 31-Feb. 1, 1909	32	n.			
Feb. 17-18, 1909	28	n.	Jan. 4-5, 1916	31	n.
Jan. 16-19, 1910	27	n.	Jan. 19-21, 1916	31	n.
Jan. 30-31, 1910	31	n.	Jan. 23-25, 1916	33	n.
Feb. 13-15, 1910	36	nw.	Feb. 3-5, 1916	32	ne.
Dec. 3, 1910	38	n.	Feb. 8-10, 1916	30	ne.
			Feb. 20-21, 1916	27	n.
Feb. 16-18, 1911	27	ne.	Feb. 26-28, 1916	27	n.
Feb. 23-24, 1911	30	n.	Mar. 4-6, 1916	30	n.
Mar. 6-7, 1911	26	ne.	Mar. 17-21, 1916	34	n.
Apr. 14-17, 1911	28	n.	Dec. 28, 1916-Jan. 3, 1917	33	nw.
Nov. 30-Dec. 2, 1911	34	ne.			
Dec. 28-31, 1911	34	ne.	Jan. 16-18, 1917	33	nw.
			Jan. 20-21, 1917	25	nw.
Jan. 5-6, 1912	32	ne.	Jan. 27-Feb. 3, 1917	36	nw.
Jan. 21-25, 1912	27	n.	Feb. 6-7, 1917	28	nw.
Feb. 27-Mar. 5, 1912	33	ne.	Feb. 11-12, 1917	26	nw.
Mar. 14-21, 1912	28	ne.	Feb. 19-25, 1917	39	nw.
Apr. 23-27, 1912	33	ne.	Mar. 2, 1917	27	ne.
Nov. 18-20, 1912	33	nw.	Mar. 6, 1917	27	ne.
			Mar. 8-16, 1917	29	ne.
Feb. 10-12, 1913	32	ne.	Mar. 18-22, 1917	32	ne.
Mar. 7-9, 1913	31	ne.	Nov. 4-5, 1917	40	nw.
Mar. 17-19, 1913	36	ne.	Nov. 24-25, 1917	42	nw.
Mar. 22-24, 1913	31	ne.			
Dec. 27-28, 1913	32	ne.			
Feb. 8-10, 1914	28	ne.			
Feb. 15-18, 1914	28	ne.			
Mar. 8-14, 1914	35	ne.			
Mar. 22-28, 1914	28	n.			
Apr. 22-23, 1914	29	n.			

—*R. Z. Kirkpatrick, Chief Hydrographer, Canal Zone.*

Study in detail of 26 of the more important of the northers disclosed that while all were ultimately due to strong high pressure to the northward with steep gradients, yet the preceding pressure distribution may be of at least four closely related types. One map of each type, for a day immediately preceding the occurrence of a norther, is here reproduced as figures 1–4. The first type (fig. 1), preceded the norther of February 13–15, 1910, when the wind at Colon, Canal Zone, reached a velocity of 36 miles an hour from the northwest. On the morning of February 11, 1910, pressure was low over the eastern Gulf States and the eastern Gulf of Mexico—center of 29.72 inches at Pensacola, Fla.—with general and marked high pressure over the remainder of the United States—30.72 inches over the upper St. Lawrence Valley, 30.48 inches over North Dakota. Gradients were steep northeastward.

The second type (fig. 2) preceded the norther of March 17–19, 1913, when the wind at Colon reached a velocity of 36 miles an hour from the northeast. On the morning of March 15 pressure was low over the eastern half of the United States—29.32 inches at Alpena, Mich—and high over the western half of the United States as well as over the Atlantic Ocean—30.54 inches over Wyoming and 30.30 inches over Bermuda, with steep gradients especially in the central West. The low pressure extended down to the Gulf coast giving 29.78 inches at Pensacola, Fla.

The third type (fig. 3) preceded the norther of December 28, 1916–January 3, 1917, when the wind at Colon reached a velocity of 33 miles an hour from the northwest. On the morning of December 26 marked low pressure covered the Plains States—29.30 inches over eastern South Dakota, 29.60 inches over southern Texas with equally marked high pressure over the eastern half of the United States—30.66 inches at Cochrane, Ontario. Gradients were very steep everywhere except over Texas. The fourth type (fig. 4) preceded the norther of November 4–5, 1917, when the wind at Colon reached a velocity of 40 miles an hour from the northwest. On the morning of November 3, pressure was low (29.82 in.) over the entire Caribbean Sea, and high over the eastern United States—30.60 inches over western Tennessee.

The four types may be summarized as follows:

1. Low pressure over Gulf of Mexico, and high pressure to northward and northwestward.
2. Low pressure over eastern half of the United States extending down to the Gulf of Mexico, and high pressure over the western half of the United States with steep gradients, especially westward. This type is accentuated whenever high pressure prevails also over the middle Atlantic Ocean.
3. The reverse of No. 2.
4. Low pressure over the Caribbean Sea and high pressure over the eastern United States. Gradients not essentially as steep as in the preceding types, yet, nevertheless, well marked.

Following is a map showing the locations of the meteorological stations in the Canal Zone and a portion of Panama.

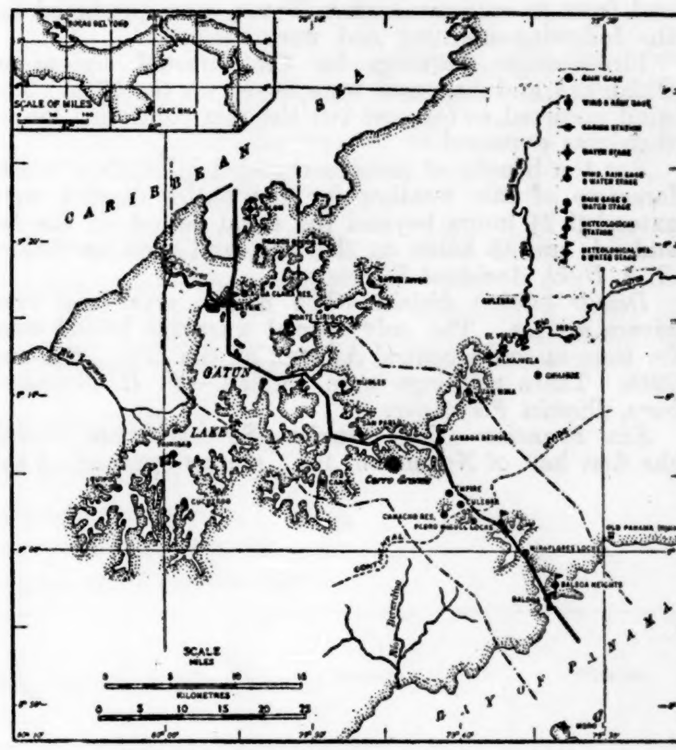

FIG. 5.—Location of meteorological stations in Canal Zone.

WARNINGS FROM OTHER DISTRICTS.

Chicago (Ill.) district.—No warnings were issued by this district during November, 1917.—*Chas. L. Mitchell, Assistant Forecaster.*

New Orleans (La.) district.—The weather was unusually free from disturbances. Although maximum wind velocities of 32 to 33 miles per hour slightly exceeding the verifying velocity of 30 miles, occurred at Galveston, Texas, on the 18th, 19th, and 22d, they were of too short duration to constitute storms, and the preceding conditions furnished no definite indication of their probability. No storm warnings were issued. In marked

contrast with the preceding month, no cold waves occurred and no cold-wave warnings were issued.

The anticyclonic conditions that continued over and to the eastward of this district during the first ten days resulted in cold nights, low wind movement, and the accumulation of much haze and smoke.

Frost warnings were issued as follows, and were justified:

Frost for southern Louisiana was forecast daily from the 1st to the 7th, inclusive; for the southern portion of eastern Texas, except in the lower Rio Grande Valley, on the 1st and 2d; and for the eastern half of the southeastern portion of eastern Texas on the 4th.

Frost was forecast on the 12th for the interior of Louisiana and of the southern portion of eastern Texas, except in the lower Rio Grande Valley; on the 15th and 16th, for Louisiana and extreme eastern Texas, with freezing in the interior of Louisiana in the forecast of the 15th; on the 20th, for Louisiana and eastern Texas, to the coast, with heavy frost in the interior; on the 22d, for the southern portion of Texas except on the immediate coast and in the lower Rio Grande Valley.

Temperatures lower than those anticipated from the preceding conditions occurred in Louisiana on the morning of the 24th, with freezing in the interior. Frost to the coast and freezing nearly to the coast in Louisiana, and frost in extreme eastern Texas, were predicted for the following morning and were verified.

Fire-weather warnings for the forested regions of Oklahoma and Arkansas were issued on the 17th. The wind occurred as forecast but the rain continued longer than was expected.

For the benefit of persons engaged in outdoor work, forecasts of fair weather for the entire district were extended 24 hours beyond the usual period on the 1st and 2d, and 48 hours on the 21st, and were verified.—*R. A. Dyke, Assistant Forecaster.*

Denver (Colo.) district.—The month was free from severe storms. The only special warnings issued were for frost in south central Arizona on the 27th, 28th and 29th. These warnings were verified.—*F. H. Brandenburg, District Forecaster.*

San Francisco (Cal.) district.—Several times during the first half of November, 1917, storms approached the northern edge of this district without causing very high winds at Weather Bureau stations, although at Triangle Island, British Columbia, about three hundred miles north of Tatoosh Island, Wash., winds varying from 60 to 76 miles were reported at the time the observation was taken. These storms moved eastward, but on account of their proximity storm warnings were issued on the 2d, 8th and 11th to our stations at the entrance to the Columbia River, Strait of Juan de Fuca, and the Gulf of Georgia. At the same time advisory messages were sent to Seattle, Tacoma, and the United States navy yard at Bremerton. While these warnings were only partly verified it is believed they were fully justified in view of the dangerous conditions prevailing but a short distance to the north. Storm warnings were also sent to northern seaports on the 26th, 27th and 29th. Verifying velocities occurred at Seattle during the night of the 27th, 28th and 29th–30th; but none was reported at the northern coast stations.

In addition storm warnings were ordered along the northern coast of California on the 29th and 30th; both were verified.

Small-craft warnings were issued on 8 occasions to two or more stations; it is believed that they served a useful purpose and were fully justified.

From the 14th to the 22d, and on the 26th and 27th, light frost formed at many places in the interior of California and also along its northern coast above Cape Mendocino. In some exposed locations the frosts were heavy, but they did no damage of consequence as the staple crops had previously been safely secured. Nearly all these frosts were predicted 24 hours in advance. Two frost warnings were issued which were not verified on account of the intervention of clouds that unexpectedly developed during the early morning.

During the middle portion of the month the weather was mostly of anticyclonic character and consequently the rain was light, especially in California and Nevada where more is badly needed for fall plowing and to start a new growth of grass for stock that had been brought from the mountains and placed on the winter ranges in the foothills and valleys.—*E. A. Beals, District Forecaster.*

SECTION IV.—RIVERS AND FLOODS.

RIVERS AND FLOODS, NOVEMBER, 1917.

By ALFRED J. HENRY, Professor in Charge.

Flood stages were not reached in the rivers in any part of the country during November, 1917.

Hydrographs for typical points on several principal rivers are shown on Chart I. The stations selected for charting are Keokuk, St. Louis, Memphis, Vicksburg, and New Orleans, on the Mississippi; Cincinnati and Cairo, on the Ohio; Nashville, on the Cumberland; Johnsonville, on the Tennessee; Kansas City, on the Missouri; Little Rock, on the Arkansas; and Shreveport, on the Red.

MEAN LAKE LEVELS DURING NOVEMBER, 1917.

By UNITED STATES LAKE SURVEY.

[Dated: Detroit, Mich., Dec. 5, 1917.]

The following data are reported in the "Notice to Mariners" of the above date:

Data.	Lakes.*			
	Superior.	Michigan and Huron.	Erie.	Ontario.
Mean level during November, 1917:	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Above mean sealevel at New York	602.46	581.16	572.97	246.69
Above or below—				
Mean stage of October, 1917	−0.21	−0.20	+0.16	+0.01
Mean stage of November, 1916	−0.99	+0.52	+1.30	+1.04
Average stage for November, last 10 years	−0.05	+1.02	+1.26	+1.17
Highest recorded November stage	−1.05	−1.76	−0.70	−1.13
Lowest recorded November stage	+0.96	+1.98	+2.27	+3.28
Average relation of the November level to—				
October level	−0.2	−0.3	−0.4	−0.3
December level	+0.2	+0.1	+0.1	+0.2

* Lake St. Clair's levels: October, 575.77; November, 575.76 feet.

MEAN LAKE LEVELS DURING OCTOBER, 1917.*

By UNITED STATES LAKE SURVEY.

[Dated: Detroit, Mich., Nov. 5, 1917.]

The following data are reported in the "Notice to Mariners" of the above date:

Data.	Lakes.			
	Superior.	Michigan and Huron.	Erie.	Ontario.
Mean level during October, 1917:	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Above mean sealevel at New York	602.67	581.36	572.81	246.68
Above or below—				
Mean stage of September, 1917	−0.06	−0.32	−0.47	−0.25
Mean stage of October, 1916	−0.97	+0.76	+0.92	+0.62
Average stage for October, last 10 years	−0.01	+0.96	+0.74	+0.88
Highest recorded October stage	−0.89	−1.58	−0.89	−1.13
Lowest recorded October stage	+1.09	+1.76	+2.01	+3.01
Average relation of the October level to—				
September level	±0.0	−0.2	−0.3	−0.4
November level	+0.2	+0.3	+0.4	+0.3

* This report was not received in time for the October issue of the REVIEW.

SECTION V.—SEISMOLOGY.

SEISMOLOGICAL REPORTS FOR NOVEMBER, 1917.

W. J. HUMPHREYS, Professor in Charge.

[Dated: Seismological Investigations, Weather Bureau, Jan. 3, 1918.]

TABLE 1.—*Noninstrumental earthquake reports, November, 1917.*

Date.	Approximate time Greenwich Civil.	Station.	Approximate latitude.	Approximate longitude.	Intensity Rossi-Forel.	Number of shocks.	Duration.	Sounds.	Remarks.	Observer.
		CALIFORNIA.								
1917.	*H. m.*		° ′	° ′			*M. s.*			
Nov. 1	13 50	Calexico	32 41	115 30	2	1		None		Ivan R. Ralston.
5	9 04	Cloverdale	38 46	123 00	3	2	4	Faint		John O. Ogle.
		Lakeport	39 04	122 56	2	2	10	Rumbling		A. S. Riggs.
13	7 50	Calexico	32 41	115 30	3	1	2½	Rumbling		H. M. Rouse.
19	17 30	El Cajon	32 48	116 58	2	1		None		H. H. Kessler.
		Indio	32 43	116 12	4	1	30	None		Bruce Drummond.
		Indio	32 43	116 12	4	1		Rumbling		Fred N. Johnson.
		Mecca	33 35	116 05	4	2	30	Rattling	Shook buildings	E. A. Palmer.
		WASHINGTON.								
12	10 47	Cedar Lake	47 24	121 43	4	1	4	None		D. A. Brown.
		Longmire	46 45	121 50	5	3	6	Rattling		John B. Flett.
		Summit Inn	47 28	121 26		2	40	Rumbling		J. P. Holden.
14	2 57	Longmire	46 45	121 50	5	1	3	Rumbling		John B. Flett.

TABLE 2.—*Instrumental reports, November, 1917.*

[Time used: Mean Greenwich, midnight to midnight. Nomenclature: International.]

[For significance of symbols see REVIEW for July, 1917, p. 373.]

Date.	Character.	Phase.	Time.	Period. T.	Amplitude.		Distance.	Remarks.
					A_E	A_N		

Alaska. *Sitka.* *Magnetic Observatory.* U. S. Coast and Geodetic Survey. J. W. Green.

Lat. 57° 03′ 00″ N.; long., 135° 30′ 06″ W. Elevation, 15.2 meters.

Instruments: Two Bosch-Omori, 10 and 12 kg.

Instrumental constants: E: V 10, T_0 16; N: V 10, T_0 15

(Report for November, 1917, not received.)

Arizona. *Tucson.* *Magnetic Observatory.* U. S. Coast and Geodetic Survey. F. P. Ulrich.

Lat., 32° 14′ 48″ N.; long., 110° 50′ 06″ W. Elevation, 769.6 meters.

Instruments: Two Bosch-Omori, 10 and 12 kg.

Instrumental constants: E: V 10, T_0 19; N: V 10, T_0 19

Date.	Character.	Phase.	Time.	Period. T.	A_E	A_N	Distance.	Remarks.
1917.			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Nov. 7	......	e_N.....	1 36 31	......	......	......	......	E-W component not working during entire month.
		M_N....	1 38 01	7	......	20	......	
		F.....	1 47 ..	......	......	......	......	
8	......	e_N.....	5 34 16	......	......	......	......	
		M_N....	5 52 16	7	......	20	......	
		F.....	6 07 ..	......	......	......	......	
16	......	eP_N...	3 32 20	......	......	......	......	
		eL_N...	3 56 ..	30	......	......	......	
		M_N....	4 20 58	16	......	20	......	
		F.....	5 15 ..	......	......	......	......	

California. *Berkeley.* *University of California.*

Lat., 37° 52′ 16″ N.; long., 122° 15′ 37″ W. Elevation, 85.4 meters.

(See Bulletin of the Seismographic Stations, University of California.)

California. *Mount Hamilton.* *Lick Observatory.*

Lat., 37° 20′ 24″ N.; long., 121° 38′ 34″ W. Elevation, 1,281.7 meters.

(See Bulletin of the Seismographic Stations, University of California.)

California. *Point Loma.* *Raja Yoga Academy.* F. J. Dick.

Lat., 32° 43′ 03″ N.; long., 117° 15′ 10″ W. Elevation, 91.4 meters.

Instrument: Two-component, C. D. West seismoscope.

Date.	Character.	Phase.	Time.	Period. T.	A_E	A_N	Distance.	Remarks.
1917.			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Nov. 3	......	......	......	......	*50	*100	......	Tremors recorded during the 24 hours preceding 13ʰ 00ᵐ on dates given.
5	......	......	......	......	*50	*100	......	
6	......	......	......	......	*50	*100	......	
7	......	......	......	......	*100	*100	......	
9	......	......	......	......	*50	*100	......	
11	......	......	......	......	*100	*200	......	
22	......	......	......	......	*50	*100	......	

*Amplitude on instrument.

California. *Santa Clara.* *University of Santa Clara.* J. S. Ricard, S. J.

Lat., 37° 26′ 36″ N.; long., 121° 57′ 03″ W. Elevation, 27.43 meters.

(See record of the Seismographic Station, University of Santa Clara.)

Colorado. *Denver.* *Sacred Heart College.* Earthquake Station. A. W. Forstall, S. J.

Lat., 39° 40′ 36″ N.; long., 104° 56′ 54″ W. Elevation, 1,655 meters.

Instrument: Wiechert 80 kg.; astatic, horizontal pendulum.

Date.	Character.	Phase.	Time.	Period. T.	A_E	A_N	Distance.	Remarks.
1917.			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Nov. 1	......	L_N....	23 30 ..	......	......	......	......	Very strong activity.
2	......	F_N....	1 40 ..	......	......	......	......	
6	......	L_N....	9	......	......	......	......	Distinct wavelets at intervals on N-S.
		F_N....	12	......	......	......	......	
7	......	L_N....	6 30 ..	......	......	......	......	Distinct wavelets appear at intervals on N-S.
		F_N....	9 15 ..	......	......	......	......	
16	......	L.....	5 31 ..	......	......	......	......	Times somewhat doubtful. P and S not discernible.
		M_N...	5 33 ..	30	......	*750	......	
		M_E....	5 33 ..	40	*750	......	......	
		C_N....	5 34 ..	......	......	......	......	
		F_N....	5 36 ..	......	......	......	......	
		C_E....	5 38 ..	......	......	......	......	
		F_E....	5 43 ..	......	......	......	......	
16	......	L.....	5 48 ..	20	*500	*500	......	Seems to be new quake. P and S not discernible.
		F.....	5 53 ..	......	......	......	......	

* Trace amplitude.

District of Columbia. *Washington.* *U. S. Weather Bureau.*

Lat., 38° 54′ 13″ N.; long., 77° 03′ 03″ W. Elevation, 21 meters.

Instrument: Marvin vertical pendulum, undamped. Mechanical registration.

Instrumental constants.... V 110, T_0 6.4

Date.	Character.	Phase.	Time.	Period. T.	A_E	A_N	Distance.	Remarks.
1917.			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Nov. 4	......	e_N.....	12 25 40	......	......	......	......	
		L.....	13 18 40	24	......	......	......	
		L.....	13 30 00	18	......	......	......	
		F.....	13 50 00	......	......	......	......	
7	......	e......	1 49 01	......	......	......	......	
		L.....	1 50 08	......	......	......	......	
		F.....	2 00 00	......	......	......	......	
8	......	e......	5 46 00	......	......	......	......	Phases not defined
		iR?....	6 06 00	......	......	......	......	
		F.....	6 20 00	......	......	......	......	
14	......	eL....	9 54 30	......	......	......	......	
		L.....	9 58 30	16	......	......	......	
		F.....	10 10 00	......	......	......	......	
15	......	eL_N...	1 56 30	......	......	......	......	
16	......	P.....	3 38 49	......	......	......	9,025	
		PR?..	3 45 05	......	......	......	......	
		S.....	3 49 01	......	......	......	......	
		L.....	4 06 50	20	......	......	......	
		L.....	4 08 10	45	......	......	......	
		L.....	4 17 00	24	......	......	......	
		L....	4 26 00	18	......	......	......	
		F.....	5 50 ..	......	......	......	......	
16	......	eL_N...	23 27 00	......	......	......	......	
18	......	P?....	3 17 16	......	......	......	......	
		L.....	4 02 00	......	......	......	......	
		L.....	4 16 40	20	......	......	......	
		F.....	4 35 00	......	......	......	......	

TABLE 2.—*Instrumental reports, November, 1917*—Continued.

District of Columbia. *Washington. Georgetown University.* F. A. Tondorf, S. J.

Lat., 38° 54′ 25″ N.; long., 77° 04′ 24″ W. Elevation, 42.4 meters. Subsoil: Decayed diorite.

Instruments: Wiechert 200 kg. astatic horizontal pendulums, 80 kg. vertical.

Instrumental constants	V	T_0	ε
E	165	5.4	0
N	143	5.2	0
Z	*80*	*3.0*	*0*

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1917.			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Nov. 4	....	e_N	12 25 08					Interpretation difficult; heavy microseisms present.
		e_E	12 25 27					
		L	13 08 13	30				Sheet taken off at 13h 22m, quake still on.
7	....	S_E?	1 49 11					Microseisms present.
		S_N?	1 49 18					
		L_N	1 50 12	10				
		L_E	1 51 20	10				
		F	2 06 ..					
14	....	e_E	9 37 56					Heavy microseisms present.
		e_N	9 37 58					
		L	9 58 30	22				
		F	10 31 00					
15	....	e	1 52 06					Only N-S component shows.
		F	2 20 ..					Heavy microseisms present.
16	....	e	3 39 01					Do.
		S_E?	3 49 03					S difficult.
		S_N?	3 49 20					Recorded on vertical instrument.
		eL_N	4 07 00	30				
		eL_E	4 10 48	32				
		M_E	4 18 24	25	*600			
		M_N	4 26 37	25		*400		
18	....	eL	3 56 12					F lost in microseisms.
		L	4 07 50	30				

Hawaii. *Honolulu. Magnetic Observatory.* U. S. Coast and Geodetic Survey. Frank Neumann.

Lat., 21° 19′ 12″ N.; long., 158° 03′ 48″ W. Elevation, 15.2 meters.

Instrument: Milne seismograph of the Seismological Committee of the British Association, E-W component.

Instrumental constant....T_0 18.6

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1917.			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Nov. 4	....	e	12 22 ..					
		M	13 01 36		*300			
		F	14 46 ..					
7	....	e	1 52 00					
		M	1 56 00	22	*100			
		F	2 01 ..					
8	....	e	18 46 30					
		M	18 50 12	18	*100			
		F	18 54 ..					
14	....	eP	9 29 36					
		eL	9 31 36	21				
		M	9 38 06	18	*300			
		C	9 44 00					
		F	10 38 ..					
15	....	e	1 30 54					
		M	1 37 50	18	*100			
		F	1 43 00					
15	....	e	17 58 00					
		M	18 10 00	18	*100			
		F	18 16 ..					
16	....	P	3 28 18					
		S	3 36 12					
		eL	3 49 30	20				
		M	3 51 48	20	*5200			
		C	3 57 ..					
		F	7 21 ..					

*Trace amplitude.

Hawaii. *Honolulu. Magnetic Observatory*—Continued.

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1917.			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Nov. 16	....	P	22 38 06					
		eL	22 51 36	28				
		M	22 58 54	23	*600			
		C	23 06 ..					
		F	23 30 ..					
17	....	e	8 34 54					
		M	8 49 12	17	*100			
		F	9 05 ..					
18	....	eP	3 12 30					
		S	3 21 00					
		eL	3 34 12	25				
		M	3 46 54	17	*1200			
		C	3 56 ..					
		F	4 47 ..					
21	....	e	0 28 42					
		M	0 33 18	18	*100			
		F	0 38 ..					
22	....	eP	6 30 ..					
		M	6 44 00	19	*100			
		F	6 47 ..					
22	....	e	23 45 30					
		M	23 57 06	19	*100			
23		F	0 02 ..					
24	....	eP	11 20 48					
		S	11 28 42					
		eL	11 36 18	26				
		M	11 43 00	19	*300			
		C	11 49 ..					
		F	12 15 ..					
24	....	e	20 10 30					
		M	20 16 54	19	*200			
		F	20 21 ..					
28	....	e	2 53 48					
		M	3 01 54	20	*100			
		F	3 16 ..					
29	....	eL	22 35 18					
		M	22 45 00	20	*400			
		C	22 48 30					
		F	23 00 00					
30	....	eP	17 24 18					
		S	17 28 00					
		eL	17 30 48	20				
		M	17 35 00	18	*900			
		C	17 38 ..					
		F	18 23 ..					

* Trace amplitude.

Kansas. *Lawrence. University of Kansas.* Department of Physics and Astronomy. F. E. Kester.

Lat., 38° 57′ 30″ N.; long., 95° 14′ 58″ W. Elevation, 301.1 meters.

Instrument: Wiechert.

Instrumental constants	V	T_0	ε
E	177	3.4	4:1
N	205	3.4	4:1

(Report for November, 1917, not received.)

Maryland. *Cheltenham. Magnetic Observatory.* U. S. Coast and Geodetic Survey. George Hartnell.

Lat., 38° 44′ 00″ N.; long., 76° 50′ 30″ W. Elevation, 71.6 meters.

Instruments: Two Bosch-Omori, 10 and 12 kg.

Instrumental constants	V	T_0
E	10	15
N	10	15

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1917			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Nov. 16	....	eP_E	3 49 ..					Just perceptible on N–S component at 4h 27m.
		eL_E	4 14 ..	24				
		M_E	4 27 ..	16	100			
		C_E	5 17 ..					

TABLE 2.—*Instrumental reports, November, 1917*—Continued.

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.

Massachusetts. *Cambridge. Harvard University Seismographic Station.* J. B. Woodworth.

Lat., 42° 22′ 36″ N.; long., 71° 06′ 59″ W. Elevation, 5.4 meters. Foundation: Glacial sand over clay.

Instruments: Two Bosch-Omori 100 kg. horizontal pendulums (mechanical registration).

Instrumental constants..		V	T_0	ϵ
	E	80	23	0
	N	50	25	4:1

(Report for November, 1917, not received.)

Missouri. *Saint Louis. St. Louis University.* Geophysical Observatory. J. B. Goesse, S. J.

Lat., 38° 38′ 15″ N.; long., 90° 13′ 58″ W. Elevation, 160.4 meters. Foundation: 12 feet of tough clay over limestone of Mississippi system, about 300 feet thick.

Instrument: Wiechert 80 kg. astatic, horizontal pendulum.

Instrumental constants.. V 80, T_0 7, ϵ 5:1

Date.	Character.	Phase.	Time.	Period. T.	A_E	A_N	Distance.	Remarks.
1917.			*H. m. s.*	*Sec.*	*μ*	*μ*	*km.*	
Nov. 7		P_N	2 04 30					Barely perceptible
		F_N	2 05 30					
7		eP_N	9 41 00					
		M_N	9 46 30					
		M_E	9 46 30					
		F_N	9 53 ..					
16		eP_E	3 43 30					
		eP_N	3 44 30					
		S_N	4 03 ..					
		S_E	4 10 ..					
		M_N	4 23 ..					
		M_E	4 25 ..					
		F	5 00 ..					

New York. *Buffalo. Canisius College.* John A. Curtin, S. J.

Lat., 42° 53′ 02″ N.; long., 78° 52′ 40″ W. Elevation, 190.5 meters.

Instrument: Wiechert 80 kg. horizontal.

Instrumental constants.. V 80, T_0 7, ϵ 5:1

(Report for November, 1917, not received.)

New York. *Fordham. Fordham University.* Daniel H. Sullivan, S. J.

Lat., 40° 51′ 47″ N.; long., 73° 53′ 08″ W. Elevation, 23.9 meters.

Instrument: Wiechert, 80 kg.

Instrumental constants.		V	T_0	ϵ
	E	72	6.6	1.5:1
	N	72	7.1	3.8:1

(Report for November, 1917, not received.)

New York. *Ithaca. Cornell University.* Heinrich Ries.

Lat., 42° 26′ 58″ N.; long., 76° 29′ 09″ W. Elevation, 242.6 meters.

Instruments: Two Bosch-Omori, 25 kg., horizontal pendulums (mechanical registration).

Instrumental constants.		V	T_0	ϵ
	E	13	22	4:1
	N	14	25	4:1

Date.	Character.	Phase.	Time.	Period. T.	A_E	A_N	Distance.	Remarks.
1917.			*H. m. s.*	*Sec.*	*μ*	*μ*	*km.*	
Nov. 7		e_N	1 49 15	4–10				
		F	1 59 ..					
8		e_N	6 05 ..	4–10				
		F	6 16 ..					
16		e_E	3 48 55	20				
		L_N	4 08 48	52				
		F_N	5 40 ..					

Panama Canal Zone. *Balboa Heights.* Isthmian Canal Commission.

Lat., 8° 57′ 39″ N.; long., 79° 33′ 29″ W. Elevation, 27.6 meters.

Instruments: Two Bosch-Omori, 100 kg.

Instrumental constants.. V 35, T_0 20

Date.	Character.	Phase.	Time.	Period. T.	A_E	A_N	Distance.	Remarks.
1917.			*H. m. s.*	*Sec.*	*μ*	*μ*	*km.*	
Nov. 13		P	8 59 02				300	Direction probably north.
		L_E	8 59 43					
		L_N	8 59 48					
		M_E	9 00 01		*500			
		M_N	9 00 06			*1,000		
		F	9 06 00					
16		L_N	4 05 09					Very distant. Time not working on N-S component.
		M	4 17 09		*1,500	*500		
		F	4 35 09					

* Trace amplitude.

Porto Rico. *Vieques. Magnetic Observatory.* U. S. Coast and Geodetic Survey. F. L. Adams.

Lat., 18° 09′ N.; long., 65° 27′ W. Elevation, 19.8 meters.

Instruments: Two Bosch-Omori.

Instrumental constants..		V	T_0
	E	10	17.5
	N	10	18.0

Date.	Character.	Phase.	Time.	Period. T.	A_E	A_N	Distance.	Remarks.
1917.			*H. m. s.*	*Sec.*	*μ*	*μ*	*km.*	
Nov. 16		eP_N	3 48 ..					
		eL_E	4 15 ..	30				
		eL_N	4 17 ..	25				
		M_E	4 18 30	22	40			
		M_N	4 19 30	24		60		
		C	4 38 ..					
		F	5 01 ..					

Vermont. *Northfield. U. S. Weather Bureau.* Wm. A. Shaw.

Lat., 44° 10′ N.; long., 72° 41′ W. Elevation, 256 meters.

Instruments: Two Bosch-Omori, mechanical registration.

Instrumental constants..		V	T_0
	E	10	15
	N	10	16

Date.	Character.	Phase.	Time.	Period. T.	A_E	A_N	Distance.	Remarks.
1917.			*H. m. s.*	*Sec.*	*μ*	*μ*	*km.*	
Nov. 16		S?	3 49 28					Beginning occurred while sheets were being changed.
		SR	3 55 32					
		eL	4 10 00					
		L	4 16 00	35				
		L	4 22 20	20				
		F	5 30 00					

Canada. *Ottawa. Dominion Astronomical Observatory.* Earthquake Station. Otto Klotz.†

Lat., 45° 23′ 38″ N.; long., 75° 42′ 57″ W. Elevation, 83 meters.

Instruments: Two Bosch photographic horizontal pendulums, one Spindler & Hoyer 80k. vertical seismograph.

Instrumental constants.. V 120, T_0 26

Date.	Character.	Phase.	Time.	Period. T.	A_E	A_N	Distance.	Remarks.
1917.			*H. m. s.*	*Sec.*	*μ*	*μ*	*km.*	
Nov. 4		eL_E	{13 07 .. / 13 40 ..}	16				
7		e	1 50 34					
		eL?	{1 51 12 / 1 53 ..}	9				
		F	1 59 ..					
8		e	5 49 ..	6				
		e_E	5 51 42	6				
		e_E	6 05 47	2				
		e_E	6 06 13	2				
		e	6 06 56	6				
		e_E	{6 09 .. / 6 10 30}	8				
		F	6 15 ..					

†Dr. Klotz, since assuming the directorship of the observatory, will be unable to read all the seismograms, probably only those of tectonic origin. All the grams will be read by Ernest A. Hodgson, seismologist in charge.

TABLE 2.—*Instrumental reports, November, 1917*—Continued.

Canada. *Ottawa. Dominion Astronomical Observatory*—Continued.

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1917.			H. m. s.	Sec.	μ	μ	km.	
Nov. 14		eL	{9 49 .. / 9 56 ..}	20				
		iL_N	9 57 ..	16				
		L	10 02 ..	16				
		F	10 10 ..					
15		eL_N	{1 51 .. / 1 59 ..}	14				
16		*O*	*3 26 09*				9,560	
		P	3 38 50					
		i	3 47 35	8				
		S	3 49 28	10				
		SR1	3 55 50					
		eL	4 09 ..	50				
		L	4 13 ..	26				
		L	4 25 ..	17				
		L	4 35 ..	17				
		L	4 48 ..	15				
		L	4 55 ..	14				
		L	5 05 ..	14				
		L R1	5 26 ..	26				
		F	6 00 ..					
		eL_N	{23 22 .. / 23 29 ..}	24				
18		e_N	3 17 40	5				N-S component masked considerably by microseisms.
		eL_N	3 57 ..	30				
		L	{4 10 .. / 4 15 ..}	24				
		L_N	4 25 ..	16				
		F	4 35 ..					
24		eL_N	{12 10 .. / 12 18 ..}	24				N-S masked by microseisms.

Canada. *Toronto. Dominion Meteorological Service.*

Lat., 43° 40′ 01″ N.; long., 79° 23′ 54″ W. Elevation, 113.7 meters. Subsoil: Sand and clay.

Instrument: Milne horizontal pendulum, North. In the meridian.

Instrumental constant.. T_0 18. Pillar deviation: 1 mm. swing of boom=0.50″.

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1917.			H. m. s.	Sec.	μ	μ	km.	
Nov. 4		L	13 04 54					Markings at 12h 43m 06s and 12h 52m 36s may be due to air currents.
		L	13 14 36					
		L	13 19 48					
		M	13 49 06		*300			
		F?	14 57 30					
7		L	1 49 48					
		M	1 51 00		*300			F in air currents.
8		L	6 04 48		*100			Air currents going on.
14		L	9 51 48					
		eL	9 57 18					
		M	9 58 00		*300			
		F	10 31 42					
15		L	1 58 12					Doubtful as to being seismic.
		M	1 58 30		*200			
16		eP	3 38 36				10,310	
		iS	3 49 48					S waves well defined.
		iS	3 50 30					
		L	4 09 36					
		L	4 23 12					
		M	4 25 36	18	*9,200			
		iL	4 32 30	12-18				
		L	5 45 54					
		F?	7 01 00					
16		L	23 21 12					
		L	23 41 18		*100			
		F	23 56 54					
18		L	3 36 30		*50			
		F	3 42 24					
18		L?	4 01 06					
		L	4 10 48					
		M	4 21 36		*200			
		F	5 02 06					
24		L	{12 11 24 / 12 16 26}		*50			
29		L?	22 56 18					
		L?	23 03 54		*50			
30		L	18 05 06					
		L	18 08 30		*50			
		F?	18 25 36					

* Trace amplitude.

Canada. *Victoria, B. C. Dominion Meteorological Service*

Lat., 48° 24′ N.; long., 123° 19′ W. Elevation, 67.7 meters. Subsoil: Rock.

Instrument: Wiechert, vertical; Milne horizontal pendulum, North. In the meridian.

Instrumental constant.. T_0 18. Pillar deviation, 1 mm., swing of boom=0.54″.

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.
1917.			H. m. s.	Sec.	μ	μ	km.	
Nov. 4		P	12 33 02				13,000	
		S?	12 46 48					
		L	12 53 41					
		M	13 20 14		*600			
		F	13 49 45					
7		P?	0 49 12					
		M	1 48 18		*400			
14		P or S.	9 30 26					
		L	9 39 22					
		M	9 46 18		*100			
		F	9 35 15					
16		P	3 32 27				9,290	
		S	3 42 52					
		L	3 57 15					
		M	4 11 08		*3,000			
		F	6 33 27					
			VERTICAL		A_Z			
		P	*3 32 00*	*3-4*				
		L	*4 02 00*	*24*				
		M	*4 05 00*	*30*	*10*			
16		L	23 19 01		50			
18		L?	3 22 35					
		M	3 30 30		*100			
18		P?	3 41 54					
		S?	3 46 22					
		L?	3 54 48					
		M	4 02 04		*200			
		F	4 44 23					
28		P?	15 21 31					May not be a 'quake.
		M	15 23 29		*100			
		F	15 26 28					
29		L	23 00 09					
		M	23 04 09		*300			
		F	23 09 30					
30		S?	17 44 43					
		L?	17 48 42					
		M	17 55 38		*500			
		F	18 05 01					

* Trace amplitude.

TABLE 3.—*Late reports (instrumental).*

Date.	Character.	Phase.	Time.	Period. T.	Amplitude. A_E	Amplitude. A_N	Distance.	Remarks.

Hawaii. *Honolulu. Magnetic Observatory.* U. S. Coast and Geodetic Survey. Frank Neuman.

Lat., 21° 19′ 12″ N.; long., 158° 03′ 48″ W. Elevation, 15.2 meters.

Instrument: Milne seismograph of the Seismological Committee of the British Association.

Instrumental constant.. T_0 18.5

Date.	Character.	Phase.	Time.	Period. T.	A_E	A_N	Distance.	Remarks.
1917.			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Oct. 6	......	eP	13 02 00					
		eL	13 06 24	19				
		M	13 07 00		*200			
		C	13 09 00					
		F	13 30 00					
7	......	eP	15 21 54					
		eL	15 49 00	26				
		M	15 57 12	18	*200			
		C	16 02 00					
		F	16 09 00					
14	......	eP	3 26 00					
		eL	3 38 54	20				
		M	3 43 54	19	*500			
		C	3 49 00					
		F	3 58 00					
17	......	eL	15 09 36	26				
		M	15 18 42	18	*400			
		C	15 24 00					
		F	15 37 00					
22	......	eP	7 42 06					
		eL	7 59 00	20				
		M	8 01 12	18	*200			
		C	8 03 00					
		F	8 48 00					
23	......	eP	1 21 06					
		L	1 24 00	18				
		M	1 24 30	18	*300			
		C	1 33 00					
		F	1 49 00					
24	......	e	3 03 06					
		M	3 04 54	17	*100			
		F	3 07 00					
25	......	eP	20 06 00					
		eL	20 15 18	18				
		M	20 24 18	19	*200			
		C	20 27 00					
		F	20 51 00					
27	......	e	6 55 12	21				
		M	7 00 00	19	*100			
		C	7 03 00					
		F	7 21 00					
28	......	eL	13 57 36	23				
		M	14 02 24	18	*200			
		C	14 05 00					
		F	14 35 00					
31	......	eP	2 27 00					
		eL	2 35 00	20				
		M	2 39 42	19	*200			
		C	2 44 00					
		F	2 57 00					

*Trace amplitude.

New York. *Ithaca. Cornell University.* Heinrich Ries.

Lat., 42° 26′ 58″ N.; long. 76° 29′ 09″ W. Elevation, 242 meters.

Instruments: Two Bosch-Omori, 25 kg., horizontal pendulums (mechanical registration)

Instrumental constants..		V	T_0	ϵ
	E	13	22	4:1
	N	14	25	4:1

Date.	Character.	Phase.	Time.	Period. T.	A_E	A_N	Distance.	Remarks.
1917.			*H. m. s.*	*Sec.*	μ	μ	*km.*	
Oct. 19	......	eLN	16 53 45					
		FN	17 16 ..					
22	......	eLN	7 42 08	22				
		FN	8 10 ..					

SEISMOLOGICAL DISPATCHES.[1]

Portland, Oreg, Nov. 16, 1917.

Mount Rainier has been shaken twice this week by earthquakes, according to Prof. John Plett, who has been in the Government service at Rainier National Park for many years. He declares rocks have come hurtling down the mountain side, and his office severely shaken. (Associated Press).

Melbourne, Australia, Nov. 18, 1917.

An earthquake of unusual intensity was recorded here to-day and also at Sydney. The disturbance was located approximately in the Kermadec Islands, a small British archipelago off the east coast of Australia. (Associated Press.)

MINNESOTA'S EARTHQUAKE OF SEPTEMBER 3, 1917.

By Prof. C. J. POSEY.

[Dated: Department of Geology, University of Minnesota, Minneapolis, Nov. 28, 1917.]

It is well known that earthquakes occur much more frequently in some parts of the world than in others. In some regions a shock must be rather severe in order to receive more than passing notice, while in others even a slight tremor arouses general interest, so infrequently are earthquakes experienced. It is to this latter class that the upper Mississippi valley belongs.

About 3:30 on the afternoon of September 3, 1917, a slight earthquake was felt in central Minnesota, which is of interest not so much on account of its severity, or lack of it, as of the fact of its occurrence. So far as the writer has been able to learn there are no written accounts of earthquakes within the limits of the State since its settlement. That they have occurred here we know from the testimony of old settlers. The Long Prairie Leader of September 6, 1917, quotes Hon. Wm. E. Lee, of that city, as saying that "the vicinity experienced a harder shock in 1860, one that would have done damage had the country been more thickly settled at that time." In a recent letter to Mr. Warren Upham, Mr. Ora J. Parker, of Le Sueur, writes of an earthquake there on a Sunday afternoon between 1865 and 1870, a shock that was generally talked about the next day. It is not likely that these gentlemen refer to the same disturbance, for the dates do not coincide, and the two localities referred to are so far apart that a quake severe enough to be felt at the two places would have been more generally remembered.

The shock of September 3, 1917, was most severe at Staples, notheastern Todd County; at Lincoln, some 15 miles to the southeast in Morrison County; and at Brainerd, about 30 miles to the east, in Crow Wing County. Along a line running north of east and slightly oblique to this east-west line, the disturbance was felt at places approximately 110 miles apart; and along a line connecting Brainerd and Minneapolis it was felt for a maximum distance of about 120 miles. The total area over which the shock was felt was probably not more than 10,000 square miles. The distance it was felt east of Brainerd was about the same as that west of Staples; but along the northwest-southeast line it was felt several times as far to the south of Brainerd as to the north, thus showing that the disturbance was damped more rapidly northward.

[1] Reported by the organization indicated and collected by the seismological station at Georgetown University, Washington, D. C.

An inspection of the accompanying table shows that but one shock is generally reported, though two places indicate two shocks and two others mention three. The places experiencing more than one shock are so scattered that there is no apparent reason why they should have had the extra numbers. The reported duration of the shocks varied from one second at Aldrich to 25 seconds at Motley, both places ranking high in intensity. Perhaps a fair average of the duration would be 10 seconds. Those places experiencing three shocks give a total duration of less than 10 seconds. The accompanying sounds are generally described as a rumbling noise, similar to that of an incoming train or heavily laden trucks.

TABLE 1.—*Noninstrumental reports on the Staples earthquake.*

[Adapted from the U. S. Weather Bureau seismological reports for Sept., 1917.]

Day.	Station.	Intensity Rossi-Forel.	Number of shocks.	Duration.	Sounds.	Remarks.
1917.				*Secs.*		
Sept. 3, 3:30 p.m	Aldrich	5	1	1	Rumbling	
	Alexandria	3	1			Dishes and pans rattled.
	Brainerd	5–6	3	7	Rumbling	Bricks fell from chimneys.
	Crosby	4	1	5	Rumbling	
	Crow Wing		1		Rumbling	
	Eagle Bend	4–5	1	20	Rumbling	
	Fort Ripley		1		Rumbling	
	Henning	3–4			Faint	Dishes jarred.
	Grant	5	1	20	Rumbling	
	Gull Lake Dam	4–5	1	10	Rumbling	
	Jenkins	4–5	1			Shook buildings.
	Leader	5	1	5	Rumbling	Windows and stoves rattled.
	Lincoln	6	1		Rumbling	Plaster cracked; stove pipe thrown down.
	Little Falls			20	Rumbling	Dishes and stove lids rattled.
	Long Prairie	3	1		None	Caused some alarm windows rattled.
	McGregor	3	1	2	Rumbling	
	Merrifield	3	1	6	Rumbling	
	Milaca	3				Dishes rattled.
	Minneapolis	2–3	1	10	None	
	Motley	5	1	25	Rumbling	
	Onamia	3			Rumbling	
	Park Rapids	2	1			
	Parkers Prairie	5	1	20	Rumbling	
	Philbrook	5	2		Rumbling	
	Pierz	3	1		Rumbling	
	Pillager	5	2	20	Rumbling	
	Pine River Dam.					
	Pequot	4–5	3	6	Rumbling	Goods shaken off shelf.
	Saint Cloud	2	1			
	Sauk Center	3	1	6		
	Staples	6	1	10–20	Rumbling	Walls cracked; cement floor cracked.
	Sylvan	5			Rnmbling	
	Verndale		1	20	Rumbling	Rattled dishes and windows.
	Wadena				Rumbling	

Based on an adapted Rossi-Forel scale, the intensities were not above VI, only three places, Staples, Lincoln, and Brainerd, being of this higher number. The greater disturbances generally follow the Crow Wing-Missisippi valleys between Staples and Brainerd. From the noninstrumental data received, the accompanying figure showing the isoseismal lines of intensity III and above has been drawn.

As might be expected from an intensity of only VI, little damage was done. The wall on one side of a brick building in Staples was cracked, as was also the cement floor in the vault of the city clerk's office. The only damage mentioned from Brainerd was the dislodging of several courses of brick from a chimney there. A chimney was thrown down near Lincoln. In no case were windows reported broken.

The cause of the earthquake is obscure. The region is one of pre-Cambrian rocks that were much shattered before Cambrian times. The rocks show no evidence of recent faulting and, both because of the small area disturbed and the weakness of the rock, it is extremely unlikely that this recent disturbance was caused by faulting. The more plausible explanation is that there was a slight settling of the material of some of the filled-in preglacial valleys in that vicinity.

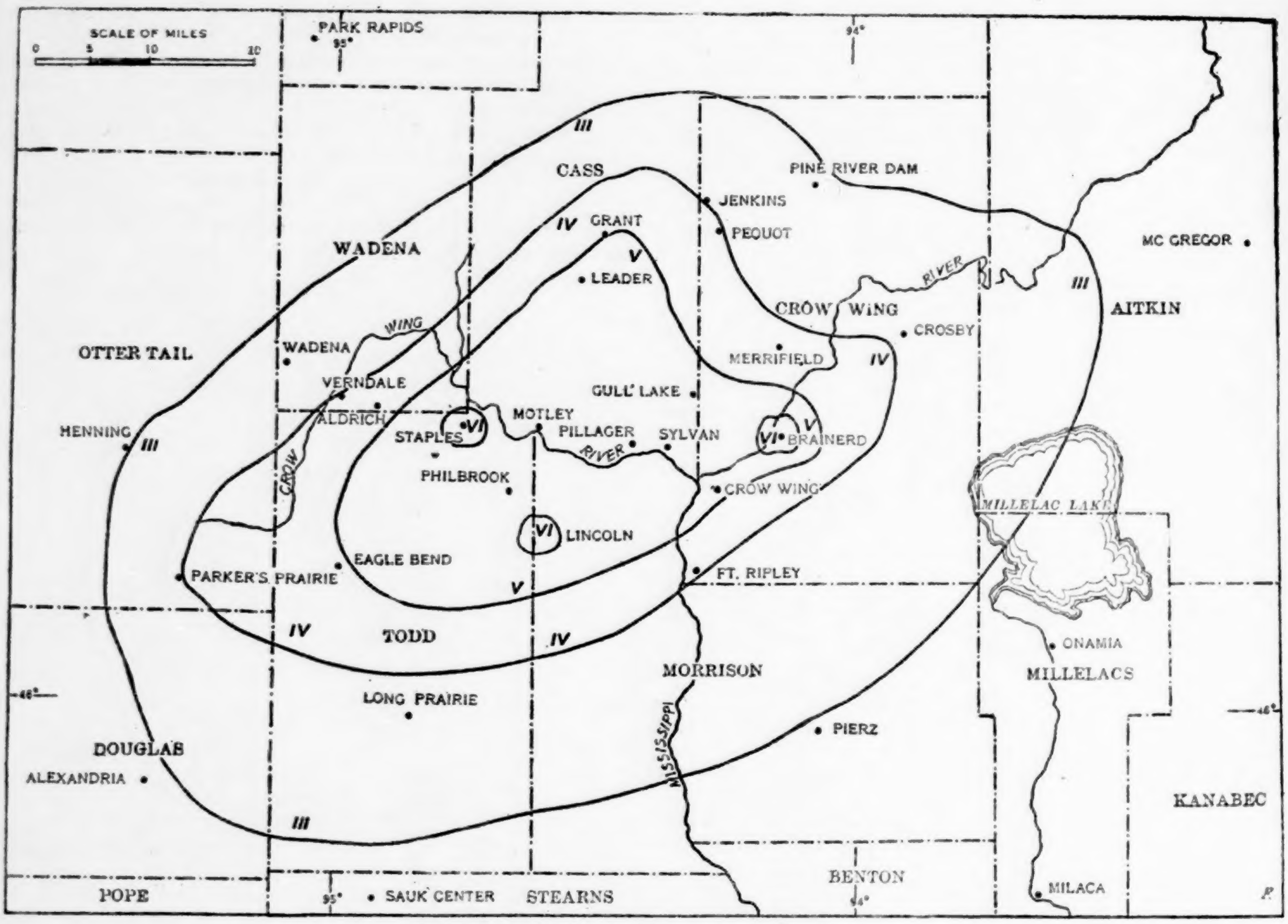

FIG. I.—Isoseismals of Staples, Minn., earthquake, Sept. 3, 1917.

SECTION VI.—BIBLIOGRAPHY.

RECENT ADDITIONS TO THE WEATHER BUREAU LIBRARY.

C. FITZHUGH TALMAN, Professor in Charge of Library.

The following have been selected from among the titles of books recently received as representing those most likely to be useful to Weather Bureau officials in their meteorological work and studies:

British rainfall, 1916. On the distribution of rain in space and time over the British Isles during the year as recorded by more than 5,000 observers in Great Britain and Ireland and discussed with articles upon various branches of rainfall work by Hugh Robert Mill and Carle Salter. The fifty-sixth annual volume. London. 1917. 256 p. front. tables. diagrams. maps. 22 cm.

Coimbra. Observatório meteorológico.
Observações meteorológicas, magnéticas e sísmicas feitas no año de 1916. Volume 55. Coímbra. 1917. viii, 165 p. incl. tables. 36½ cm.

Dixie, A. E.
Air navigation for flight officers. Portsmouth [Eng. etc. pref. 1917] x, 224 p. plate. illus. diagrams. 22½ cm.

Doberck [August] William.
Hygrometric tables for use with rotating dry and wet bulb thermometers. London. 1917. p. l., 17 p. incl. tables. 15 cm.

Fuller, George Damon.
Evaporation and soil moisture in relation to the succession of plant associations. Contributions from the Hull botanical laboratory 191. illus. 3 tables. charts. 24 cm. (Reprinted . . . from the Botanical gazette, v. 58, no. 3, Sept. 1914, p. 193-234.) Literature cited, p. 233-234.

Stratification of atmospheric humidity in the forest, by G. D. Fuller, J. R. Locke, and Wade McNutt. 2 charts. 23 cm. (Reprinted from Transactions. Illinois academy of science, v. 6, 1912, p. 100-102.)

Great Britain. Meteorological office.
The observer's handbook. Approved for the use of meteorological observers by the Meteorological office, the Royal meteorological society, the Scottish meteorological society, the British rainfall organization. Annual edition, 1917. London. 1917. xxx, 7-167 p. plates, illus. tables (part. fold.). diagrams. 24½ cm. M. O. 191 (1917).

. . . Réseau mondial, 1911. Monthly and annual summaries of pressure, temperature, and precipitation at land stations, generally two for each ten-degree square of latitude and longitude. London. 1917. xv, 112p. incl. tables. 31½ cm. At head of title: British meteorological and magnetic year book. Part V. M. O. no. 207g (Tables). Bibliography of the meteorology of the globe, p. xii.

. . . Réseau mondial, 1911. Charts showing the deviation of the pressure and temperature from normal values for each month and for the year, based on observations at land stations . . . London. 1916. 2 l. 14 fold. charts. 31½ cm. At head of title: British meteorological and magnetic year book, 1911. Part V. M. O. no. 207g (Charts).

Hepworth, M[elville] W[illis] Campbell.
The relation between pressure, temperature, and air circulation over the South Atlantic ocean. Notes with reference to a set of monthly wind charts of the South Atlantic ocean which were prepared in the Meteorological office and were originally published by the Hydrographic department of the Admiralty, in January, 1904; 2d ed. London. 1917. 14 p. charts. 24½ cm. M. O. 177 (1917).

La Cour, D[an].
Abnorme vandstandsforhold i de Danske farvande. 1. Vandstandsforholdene den 15′-16′ Januar 1916. Kjøbenhavn. 1917. 83 p. incl. tables. charts. 25½ cm. At head of title: Publikationer fra det Danske meteorologiske institut . . . Meddelelser Nr. 4.

Loveland, Lillian S.
Humidity in living rooms. How a husband and wife have made their home more comfortable and more healthful. (Photographed from the Good housekeeping magazine, v. 53, 1911, p. 674-676.) 25 cm.

Metcalf, Leonard.
American sewerage practise, by Leonard Metcalf and H. P. Eddy. New York [etc.] 1914. 3 v. plates. illus. tables. diagrams (part. fold.) 24 cm. [Chapters 6-9 discuss precipitation, storm-water flow, etc.]

Nunn, Roscoe.
William Ferrel. (Excerpted from Tennessee historical magazine, v. 3, no. 3, Sept. 1917, p. [192]-195.) 23 cm.

Panama (Republic). Direccion general de estadistica.
Boletin estadistico del quinquenio de 1912 a 1916. Sección agrícola y varios. Panama. 1917. viii, 38 p. incl. tables. 30½ cm. [Meteorology, p. 3-7.]

Panama Canal. Governor.
Annual report for the fiscal year ended June 30, 1917. Washington. 1917. xi, 414 p. plates (part. fold.) tables. diagrams (part. fold.) 23 cm. [Contains report on meteorology and hydrography.]

Philippine Islands. Weather bureau.
Annual report of the Weather bureau for the year 1915. Part III. Meteorological observations made at the secondary stations during the calendar year 1915. Manila. 1916. 339 p. incl. tables. 29 cm.

Shaw, J. J.
"Milne-Shaw" seismograph. Handbook. West Bromwich, Eng. [1917] cover-title, 28p. plates. diagrams. 25½ cm.

Shaw [William] Napier.
Revolving fluid in the atmosphere. charts (part. fold.) 25½ cm. (Reprinted from the Proceedings of the Royal society, A. vol. 94, 1917, p. [34]-52.) [Abstract in this REVIEW, September, 1917, p. 454.]

U. S. Hydrographic office.
Arctic pilot. Volume 1. The coast of Russia from Voriema or Jacob River in Europe to East Cape, Bering Strait, including off-lying islands. 1917. Washington. 1917. x, 364 p. 2 fold. maps. 23½ cm. H. O. No. 137. [Climate and weather, p. 35-43.]

RECENT PAPERS BEARING ON METEOROLOGY AND SEISMOLOGY.

G. FITZHUGH TALMAN, Professor in Charge of Library.

The following titles have been selected from the contents of the periodicals and serials recently received in the Library of the Weather Bureau. The titles selected are of papers and other communications bearing on meteorology and cognate branches of science. This is not a complete index of all the journals from which it has been compiled. It shows only the articles that appear to the compiler likely to be of particular interest in connection with the work of the Weather Bureau.

Aeronautics. London. v. 12. 1917.
Thomas, G. Holt. Commercial aeronautics. p. 388-392. (May 30.) [Discusses meteorological aspects of commercial aviation.]
Montagu of Beaulieu (Lord). The world's air routes and their regulation. p. 468-472. (June 27.) [Discusses meteorological aspects of commercial aviation.]

Aeronautics. London. v. 13. November 28, 1917.
Pannell, J. R. The wind channel: its design and use. p. 414-421. [Reviews the wind tunnel experiments and apparatus of all countries.]

British rainfall. London. v. 56. 1916.
Mill, H[ugh] R[obert]. The late Sir Alexander Binnie. p. 23-25.
Fordham, Herbert George. Or an improved method of fixing rain gauges. p. 26-27.
Salter, Carle. The measurement of rainfall duration. p. 32-40.

Franklin institute. Journal. Philadelphia. v. 184. December, 1917.
Humphreys, W[illiam] J[ackson]. Physics of the air. [Continued.] p. 805-836.

Meteorological society of Japan. Journal. Tokyo. 36th year. November, 1917.

Okada, T. On the possibility of forecasting the approximate yield of rice crop for northern Japan. p. 91-97.

Royal astronomical society of Canada. Journal. Toronto. v. 11. 1917.

Steadworthy, A. Aurora borealis; display of August 21, 1917. p. 365-366. (Nov.). [One of the illustrations, Plate 16, presents a very unusual form of aurora.]

Abbot, C[harles] G[reeley]. The sun and the weather. p. 403-416. (Dec.) [Repr. from Scientific monthly.]

Royal meteorological society. Quarterly journal. London. v. 43. October, 1917.

Brooks, C. E. P. The reduction of temperature observations to mean of 24 hours and the elucidation of the diurnal variation, in the continent of Africa. p. 375-388.

Stewart, C. D. Atmospheric electrical phenomena during rain. p. 359-374.

Royal meteorological society, etc.—Continued.

Whipple, F. J. W. Autographic records of the air-wave from the East London explosion, January 19, 1917. p. 389-400.

Mossman, R[obert] C[ockburn]. Some aspects of the cold period, December, 1916-April, 1917. p. 401-408.

Stewart, C. D. Atmospheric electricity. p. 409-431.

Royal society of London. Proceedings. London. ser. A. v. 94. no. A656. November 5, 1917.

Shaw, Napier. Revolving fluid in the atmosphere. p. 34-52.

Sociedad astronómica de España y America. Revista. Barcelona. ano 7. Sepbre-Octubre, 1917.

Navarro-Neumann, Manuel M. a S. Las series de Fourier en meteorologia. p. 65-67.

Selga, Miguel. Uniformidad de la temperatura en Manila. p. 71-73.

SECTION VII.—WEATHER AND DATA FOR THE MONTH.

WEATHER OF NOVEMBER, 1917.

P. C. DAY, Climatologist and Chief of Division.

PRESSURE AND WINDS.

The distribution of the mean atmospheric pressure over the United States and Canada, and the prevailing direction of the winds for November, 1917, are graphically shown on Chart VII, while the means at the several stations, with the departures from the normal, are shown in Tables I and III.

At the beginning of the month the pressure was relatively high throughout the United States, but in the Canadian Northwest it was slightly below the seasonal average. High pressure continued in most sections throughout the first decade, except for a few days about the middle of the period, when it was relatively low in the western half of the country. During the second decade, except for the occasional passage of a low area across the country, the pressure was likewise generally above the average. At the beginning of the third decade lower pressure prevailed over the eastern half of the country, but in a few days there was a return to higher readings, which continued until near the end of the month, when lower pressure overspread most sections of the country. The month closed with relatively low pressure throughout central districts and in the far Northwest; elsewhere it was near the normal.

For the month as whole, the barometric pressure averaged above the normal in all districts except in the New England States and the Canadian Provinces to the northeastward, where it was below the seasonal average. The departures were generally not large, although in the upper Lakes Region and portions of the Rocky Mountains they were rather pronounced.

The distribution of the HIGHS and LOWS resulted in prevailing northerly winds in the Atlantic and eastern Gulf States and portions of the upper Lakes Region, while southerly winds were frequent in much of the great central valleys. Elsewhere variable winds prevailed.

TEMPERATURE.

The month opened with temperature below the normal in all districts, except parts of the Northwest and the far West. About the middle of the first decade there was a general warming up and mild weather was the prevailing condition throughout most of the country until the middle of the month. During the next few days frost occurred in the interior of California, and it was cool in the Cotton Belt and Middle Atlantic States, and some frost occurred in the South Atlantic and eastern Gulf States. During the last decade of the month it was colder than the seasonal average in the lower Lakes Region and the North and Middle Atlantic States and about normal in the Cotton States, while elsewhere it was warmer than normal, especially in the middle and upper Missouri Valley, where it averaged about 15 degrees above the seasonal temperature.

The month as a whole was warmer than normal in most central and western districts, and cooler than the seasonal average from the lower Lakes Region, and the lower Ohio and lower Mississippi Valleys eastward. Over most of the Missouri Valley and central and northern Great Plains, the temperature for the month averaged from 6 to 15 degrees above the normal, while in some of the Canadian Provinces to the northward the positive departures were 20 degrees or more. In North Dakota and portions of the adjoining States it was the warmest November in 25 years, and November was warmer than October. The temperature averaged over 3 degrees a day below the normal in Florida, the extreme eastern Lakes Region, and along the immediate Atlantic coast.

PRECIPITATION.

During the first and second decades there was much sunshine and very little precipitation, except about the middle of the first decade, when rain fell in the Pacific States and Nevada; and during the latter part of the second decade widespread, but moderate, rain fell from the Central Plains southward and throughout the Cotton Belt. The first few days of the third decade were marked by considerable rain or snow in the Lakes Region and Northeastern States. This was followed by generally fair weather in most sections until near the end of the month, when moderate precipitation fell in the far Northwest and from the Plains Region eastward.

The precipitation for November, as a whole, was unusually light, the month being among the driest Novembers ever known in many districts. From northern Oklahoma and central Missouri northward there was decidedly little rain or snow, except in small areas. Most of the Rocky Mountain and Plateau States had less than half an inch, while in practically the whole of Arizona and portions of the adjoining States no precipitation occurred during the entire month. In the Pacific States the amounts were generally below the normal, although from 6 to 8 inches occurred in the extreme western portions of Washington and Oregon, as well as in northwestern California.

Snowfall.

During November the snowfall was unusually light, although moderate amounts fell at points in the upper Lakes Region and to the eastward. In the districts from the Rocky Mountains westward but little snow appears to have fallen, even in the high mountains.

RELATIVE HUMIDITY.

The relative humidity was above the average in the northern part of the country, except in portions of the upper Missouri Valley, where it was generally below. Elsewhere the atmosphere in most sections was relatively drier than the normal, especially from the eastern Gulf States westward to the Rocky Mountains.

GENERAL SUMMARY.

November's weather was generally favorable for outdoor occupations in practically all sections of the country and all Fall work progressed in a satisfactory manner,

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except where delayed by the scarcity of labor. The rainfall was much below the normal in practically all the winter-wheat-growing area and the dry weather delayed the germination of late sown grain and in some sections prevented plowing and seeding, but conditions were favorable for drying corn. The hardy winter truck crops were generally in good condition. The dry weather was unfavorable for pastures and ranges, particularly in the Southwest, and stock was in poor condition. The weather was favorable for the citrus and raisin crops, but strawberries in Florida needed rain.

Average accumulated departures for November, 1917.

Districts.	Temperature.			Precipitation.			Cloudiness.		Relative humidity.	
	General mean for the current month.	Departure for the current month.	Accumulated departure since Jan. 1.	General mean for the current month.	Departure for the current month.	Accumulated departure since Jan. 1.	General mean for the current month.	Departure from the normal.	General mean for the current month.	Departure from the normal.
	°F.	°F.	°F.	Ins.	Ins.	Ins.	0-10		P. ct.	
New England	36.7	−3.4	−17.0	0.85	−2.80	−3.10	4.5	−1.6	70	−6
Middle Atlantic	41.7	−2.5	−13.4	0.67	−2.20	−3.50	4.4	−1.0	69	−5
South Atlantic	51.6	−2.5	−2.4	0.70	−1.90	−10.80	3.2	−1.2	72	−4
Florida Peninsula	66.7	−3.9	−1.1	0.24	−2.00	−10.10	3.6	−0.6	70	−10
East Gulf	53.9	−1.8	−3.2	1.36	−2.10	−6.10	3.0	−1.5	65	−10
West Gulf	57.8	+1.4	+1.9	1.87	−1.30	−13.10	3.1	−1.6	66	−7
Ohio Valley and Tennessee	44.0	−0.6	−19.4	0.78	−0.30	+2.20	5.1	−0.5	73	0
Lower Lakes	36.1	−3.0	−29.8	1.00	−2.00	+0.30	6.0	−1.3	80	+4
Upper Lakes	36.1	+1.8	−30.7	0.82	−1.60	−2.90	6.1	−1.0	82	+2
North Dakota	37.8	+13.3	−7.6	0.14	−0.60	−9.20	4.7	−0.8	80	+1
Upper Mississippi Valley	42.2	+4.4	−23.7	0.25	−1.60	−3.50	5.8	+0.3	76	+2
Missouri Valley	44.8	+7.3	−7.6	0.19	−0.90	−5.50	4.7	−0.2	70	0
Northern slope	40.7	+8.7	−10.2	0.42	−0.40	−1.80	4.4	−0.7	69	0
Middle slope	48.0	+6.2	−2.9	0.25	−0.70	−7.10	3.7	−0.3	58	−5
Southern slope	53.3	+4.8	+8.7	0.27	−0.90	−8.10	2.9	−1.5	51	−15
Southern Plateau	52.9	+4.0	−1.0	0.08	−0.60	−2.70	1.4	−1.4	45	−3
Middle Plateau	42.8	+3.2	−21.4	0.51	−0.40	−2.70	4.2	−0.1	55	−6
Northern Plateau	43.4	+4.8	−7.8	1.00	−0.40	−2.30	6.1	0.0	68	−3
North Pacific	49.9	+4.4	−3.2	4.43	−2.40	−11.00	6.7	−0.9	86	0
Middle Pacific	55.3	+2.2	+0.7	1.76	−1.40	−9.40	4.8	+0.1	72	−3
South Pacific	60.0	+2.9	+9.6	0.32	−1.00	−4.30	3.1	−1.3	66	−1

WEATHER CONDITIONS OVER THE NORTH ATLANTIC OCEAN DURING NOVEMBER, 1916.

The data presented are for November, 1916, and comparison and study of the same should be in connection with those appearing in the REVIEW for that month.

Chart IX (XLV—111) shows for November, 1916, the averages of pressure, temperature, and the prevailing direction of the wind at 7 a. m. 75th meridian time (Greenwich mean noon), and notes on the locations and courses of the more severe storms of the month are included in the following summary.

PRESSURE.

The distribution of the average pressure for the month, as shown on Chart IX, differed but little from the normal over the greater part of the ocean. The North Atlantic and continental HIGHS were practically normal in position, extent, and intensity, but the Icelandic LOW, with a mean pressure of 29.48 inches, was considerably south of its usual position.

The pressure changes from day to day were unusually large in some localities; the greatest range occurred in the square between latitudes 50°-55° N. and longitudes 20°-25° W., where the lowest barometer reading was 28.22 inches on the 16th, and the highest, 30.40 inches, on the 27th.

The following table gives for a number of selected 5-degree squares the average pressure for each of the three decades of the month, as well as the highest and lowest individual readings reported during the month within the respective squares.

Pressure over the North Atlantic during November, 1916, by 5-degree squares.

Position of 5-degree square.		Decade means.			Extremes.			
					Highest.		Lowest.	
Latitude.	Longitude.	I.	II.	III.	Pressure.	Date.	Pressure.	Date.
		Inches.	Inches.	Inches.	Inches.	Nov.	Inches.	Nov.
60-65 N	20-25 W	29.41	29.50	29.62	30.18	13	28.81	27
60-65 N	0- 5 E	29.29	29.93	29.45	30.42	14	28.70	6
55-60 N	35-40 W	29.58	29.35	29.71	30.20	27	28.79	17
55-60 N	5-10 W	29.13	29.74	29.58	30.30	14	28.78	4,7
55-60 N	0- 5 E	29.35	29.94	29.66	30.42	14,15	28.90	8
50-55 N	55-60 W	29.87	29.67	29.82	30.30	29,30	29.26	10
50-55 N	45-50 W	29.67	29.49	29.78	30.26	27	29.18	17
50-55 N	20-25 W	29.45	29.42	29.85	30.40	27	28.22	16
50-55 N	0- 5 W	29.39	29.78	29.94	30.38	16	28.70	16
50-55 N	5-10 E	29.62	29.90	29.95	30.48	15	28.80	19
45-50 N	65-70 W	30.08	30.03	29.95	30.54	7	28.92	24
45-50 N	50-55 W	29.84	29.65	29.94	30.46	27	29.40	10,21
45-50 N	5-10 W	29.57	29.76	30.10	30.46	28	28.86	18
40-45 N	45-50 W	29.78	29.84	30.14	30.51	28	29.10	8
40-45 N	10-15 W	29.84	29.85	30.26	30.50	28	29.10	4
35-40 N	40-45 W	30.01	30.05	30.18	30.53	25	29.35	9
30-35 N	65-70 W	30.14	30.12	30.20	30.42	27	29.92	3
25-30 N	95-100 W	30.08	30.22	30.13	30.60	15	29.90	8
15-20 N	85-90 W	29.87	29.91	29.97	30.06	26	29.76	13

The mean and extreme values presented in the above table are based on the daily pressure values determined by interpolation for each square in the daily synoptic charts of the North Atlantic Ocean compiled by the Marine Section of the Weather Bureau.

GALES.

The number of gales and their relation to the normal differed considerably in the several portions of the ocean, as north of the 50th parallel and in the waters adjacent to the greater part of the American coast they were reported on comparatively few days, while over a large territory in mid-ocean they were considerably more numerous than usual. The greatest number occurred on the 5-degree square between latitude 45° to 50° and longitude 35° to 40°, where they were reported on 13 days, a percentage of 43, while the normal percentage for that square is 18.

On November 1 and 2 there was a LOW of moderate intensity between the 40th meridian and the American coast, that was attended by moderate gales over a limited area.

On the 2d the southern limits of a second depression extended to a point near latitude 53°, longitude 20°. By the 3d this had developed in a marked degree, the center now being near Blacksod Point, on the west coast of Ireland, where the barometer reading was 28.53 inches. No specially heavy winds were reported from any of the few vessels in the vicinity, as the highest velocity recorded was 40 miles an hour.

On the 4th this disturbance was central near latitude 48°, longitude 13° W., the pressure having changed but little since the previous day, while the storm area had increased slightly in extent. This LOW recurved toward the north and on the 5th the center was near Holyhead, England, the lowest barometer reading being 28.58 inches, with northwest gales of from 40 to 65 miles an hour over

the region between the 20th meridian and the European coast, and the 45th and 55th parallels.

On the 5th a second LOW, *I* on Chart IX, was central about 10° east of St. Johns, N. F., several vessels in the southerly quadrants having encountered moderate westerly gales.

The European LOW continued in its northerly course, and on the 6th surrounded the Shetland Islands, the wind velocities evidently having moderated since the previous day, although few vessel reports were received from the vicinity.

Low *I* moved rapidly in a due easterly direction, and on the 6th the center was near latitude 47°, longitude 27°, and winds of gale force prevailed between the 20th and 45th meridians. This disturbance curved sharply toward the northeast, and on the 7th was in the vicinity of the north coast of Scotland. Reports of gales were received from a number of vessels scattered over a large territory between the 58th meridian and the European coast, extending as far south as the 45th parallel. Low *I* moved slowly toward the northeast during the next 24 hours, as shown on Chart IX, and on the 8th conditions of wind and weather were practically the same as on the previous day, although the storm area had diminished in extent, and hail was reported by one vessel.

On the 8th a second well-developed LOW was central near latitude 44°, longitude 44°; the barometer reading was 28.85 inches and moderate to strong gales prevailed between the 33d and 60th meridians.

On the same day one vessel reported a northeasterly gale of 60 miles an hour off the southern coast of Cuba, although there was only a slight depression with a minimum reading of 29.77 inches near latitude 15°, longitude 78°. On the 9th neither LOW *I* nor the West Indies disturbance appeared on the chart, while the second LOW of the 8th was central near latitude 48°, longitude 38°, and winds of gale force prevailed over a large area, between the 30th and 52d parallels, and the 25th and 55th meridians. On the 10th this disturbance began to fill in, and the storm area had contracted in extent, although a number of vessels as far south as the Azores still encountered moderate gales.

On the 12th a LOW, *II* on Chart IX, covered the greater part of the region between Jamaica and Central America. This depression was present in the waters during nearly all the previous portion of the month, although it was of slight intensity, and accompanied by light to moderate winds. On the 12th, however, it increased in force, as the barometer fell to 29.66 inches, although there was no material increase in wind velocity. On the same day a second disturbance was central near latitude 48°, longitude 42°, and moderate gales accompanied by hail prevailed over a limited area in the southern quadrants. Low *II* moved slowly toward the northwest, and on the 13th its center was near Swan Island; the lowest barometric reading was now 29.60 inches, but there was little change in the conditions of wind and weather since the 12th. The northern LOW moved about 6° due east during the next 24 hours, and while the barometer had risen slightly, the storm area was somewhat larger on the 13th than on the previous day, moderate gales with hail and snow still prevailing. Low *II* continued on its slow northwesterly course, with little change in intensity. The northern LOW remained practically stationary in position and lost in force, although on the 14th a number of reports were received from vessels between the 37th and 57th parallels, indicating winds of gale force, with hail and snow. Low *II* curved sharply toward the north, and on the 15th the center was near the west end of Cuba, with increased intensity, and northerly gales of 60 miles an hour were encountered in the Gulf of Mexico. The northern disturbance remained in nearly the same position as on the two previous days, strong gales with hail still raging over a large territory. The center of LOW *II* did not appear on the chart after the 15th, although on the 16th moderate gales occurred in the eastern part of the Gulf of Mexico and off the eastern coast of Florida, attended by barometric readings of from 30 to 30.3 inches. The northern LOW moved rapidly toward the east, and on the 16th was central near latitude 55°, longitude 23°; with increased intensity, the minimum barometer reading being only 28.20 inches, the lowest recorded during the month. Gales of from 40 to 70 miles an hour swept over the territory between the 45th and 60th parallels, and the 15th and 35th meridians, hail also being reported by a number of vessels. The LOW moved rapidly toward the north and on the 17th the center with a minimum of less than 28.80 inches was apparently somewhere between Iceland and Greenland, although the center could not be plotted on account of lack of observations. On the same day a high with a crest of 30.24 inches was central near Boston, and while the centers of these areas were a long distance apart, strong gales with hail and snow prevailed over that part of the intermediate territory between the 40th and 50th parallels and the 35th and 55th meridians. From the 18th to the 21st a LOW covered the waters adjacent to the European coast, between the 45th and 60th parallels, but no heavy winds were reported in the immediate vicinity.

On the 18th a HIGH with a crest of 30.33 inches was central about 300 miles southwest of the Azores, while the LOW on that day was in the vicinity of northern France, the minimum reading being 28.64 inches. The steep gradient between these two areas was responsible for the northwesterly gales that prevailed over the central portion of the southern steamer lanes, where snow and hail were also reported. On the 21st and 22nd there was a LOW of slight intensity near latitude 50°, and longitude 37°, and on the former date a few vessels in the southwest quadrants reported moderate gales.

On the 24th a well-developed LOW with a minimum reading of 28.88 inches covered a large part of the Province of Quebec, strong southerly and southwesterly gales prevailing as far south as the 35th parallel, between the 60th and 70th meridians, while only moderate winds were recorded in the immediate vicinity of the American coast. This LOW evidently moved rapidly toward the north, although it was impossible to plot its center on the 25th, on account of lack of observations. Moderate gales were still encountered by a number of vessels along the American coast, between the 34th and 43d parallels, interspersed by reports of winds of not over 35 miles an hour.

The conditions during the remainder of the month were comparatively featureless, as no LOWS of marked intensity appeared during that period, although on the 30th a few vessels near the 50th parallel and 40th meridian recorded northwesterly gales of from 40 to 60 miles and hour, attended by hail and snow.

TEMPERATURE.

The average monthly temperature of the air over the ocean adjacent to the American coast, and in the northern part of the Gulf of Mexico ranged from 2 to 7 degrees above the normal, while along the European coast they were from 2 to 4 degrees above. The departures were also slightly positive in a narrow belt that extended across the ocean between the 35th and 40th parallels, while

over a large portion of the waters north and south of that area the temperatures were either normal or slightly below, the same condition holding true in the southern division of the Gulf of Mexico.

The following table gives the departures for the month at a number of Canadian and U. S. Weather Bureau Stations on the Atlantic and Gulf coasts.

	°F.		°F.
St. Johns, N. F.	−2.6	Norfolk, Va.	+1.2
Sydney, C. B. I.	−1.1	Hatteras, N. C.	+0.7
Halifax, N. S.	−0,9	Charleston, S. C.	+1.1
Eastport, Me.	−2.6	Key West, Fla.	−0.1
Portland, Me.	−1.0	Tampa, Fla.	+1.4
Boston, Mass.	+1.4	Mobile, Ala.	+2.5
Nantucket, Mass.	−0.7	New Orleans, La.	+2.0
Block Island, R. I.	−0.3	Galveston, Tex.	0.0
New York, N. Y.	+0.8	Corpus Christi, Tex.	−0.3

The lowest temperature recorded during the month was 27°, and occurred on a number of different days over the waters adjacent to the east coast of Newfoundland, while the highest reading for the same region was 46°. The seasonal fall in temperature was quite marked, especially in the higher latitudes, where the average for the last decade of the month was considerably lower than usual.

FOG.

The number of days on which fog occurred was much below the normal over the entire ocean. It was reported on 3 days, a percentage of 10, off the banks of Newfoundland where the normal percentage is from 30 to 35. In no other square was it observed on more than one day, and nearly all of the steamer lanes were entirely free.

PRECIPITATION.

The number of days on which hail was observed was apparently larger than usual, and in the square between latitude 45°–50°, longitude 40°–45°, where the maximum amount occurred, it was reported on every day from November 12th to 15th, inclusive, and again on the 17th and 23d. In the regions immediately north, east and west of this square, it was recorded on from 2 to 3 days, while east of the 30th meridian there was none.

Snow was reported on three days in the following squares: Between latitude 40°–45° and longitude 60°–65°; latitude 50°–55° and longitude 35°–40°, and also in the territory between latitude 40°–45° and longitude 40° and 50°. None was recorded in the vicinity of the European coast, or over the eastern section of the steamer routes.

Winds of 50 miles per hour (22.4 m./sec.) or over during November, 1917.

Station.	Date.	Velocity.	Direction.	Station.	Date.	Velocity.	Direction.
		Mis./hr.				*Mis./hr.*	
Block Island, R. I.	26	50	nw.	New York, N. Y.	18	56	nw.
Buffalo, N. Y.	3	52	w.	North Head, Wash.	2	50	se.
Ellendale, N. Dak.	21	54	nw.	Do.	4	58	se.
Escanaba, Mich.	22	52	ne.	Do.	27	52	s.
Kansas City, Mo.	21	66	n.	Pierre, S. Dak.	21	60	nw.
Lincoln, Nebr.	21	60	nw.	St. Joseph, Mo.	21	54	nw.
Mount Tamalpais, Cal.	5	58	nw.	St. Paul, Minn.	21	51	nw.
Do.	28	52	nw.	Sioux City, Iowa.	21	50	nw.
New York, N. Y.	6	52	nw.	Tatoosh Island, Wash.	20	58	s.

CONDENSED CLIMATOLOGICAL SUMMARY.

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course the number of such records is smaller than the total number of stations.

Condensed climatological summary of temperature and precipitation by section, November, 1917.

Section.	Temperature.								Precipitation.					
	Section average.	Departure from the normal.	Monthly extremes.						Section average.	Departure from the normal.	Greatest monthly.		Least monthly.	
			Station.	Highest.	Date.	Station.	Lowest.	Date.			Station.	Amount.	Station.	Amount.
	°F.	°F.		°F.			°F.		In.	In.		In.		In.
Alabama	51.5	− 2.7	Ozark	81	8	2 stations	20	24†	1.36	−1.62	Leeds	3.00	Camp Hill	0.00
Arizona	52.9	+ 1.8	Sentinel	95	1†	Alpine	4	27	0.00	−0.88	2 stations	0.01	109 stations	0.00
Arkansas	50.7	− 0.7	Texarkana	85	10	Dutton	11	24	1.96	−1.48	Rogers	7.07	Newport	0.35
California	54.1	+ 1.2	Riverside	98	2	Quincy	9	19	1.53	−1.3	Crescent City	15.08	16 stations	0.00
Colorado	39.6	+ 4.3	2 stations	84	4	Dillon	−10	19	0.37	−0.41	Savage Basin	1.75	4 stations	0.00
Florida	60.9	− 4.5	3 stations	85	13	3 stations	23	25†	0.57	−1.61	Fernandina	1.56	2 stations	0.00
Georgia	51.9	− 2.4	Albany	85	8	2 stations	17	25†	1.14	−1.44	Point Peter	3.99	Millen	0.20
Hawaii (October)	74.0	+ 0.4	Waianae, Oahu	95	6	2 stations	50	9	3.51	−1.55	Kealakakua, Hawaii	13.49	Puu Hele Maui	0.00
Idaho	39.9	+ 4.1	Sunnyside	77	4	Bonanza	3	27	1.56	−0.44	Oxford Ranger Sta.	3.75	Challis	0.31
Illinois	43.3	+ 1.5	2 stations	79	7	Alexander	9	24	0.69	−1.83	Carbondale	3.12	Rushville	T.
Indiana	41.8	− 0.3	2 stations	77	5†	2 stations	8	24	0.55	−2.68	Mt. Vernon	2.25	Crawfordsville	T.
Iowa	40.7	+ 5.7	Indianola	77	7	Whitten	3	24	0.28	−1.23	Sanborn	1.02	3 stations	T.
Kansas	47.6	+ 4.5	5 stations	83	3†	Leoti	11	28	0.38	−0.91	Columbus	2.61	4 stations	0.00
Kentucky	44.3	− 1.7	Earlington	78	9	2 stations	11	24†	1.25	−2.34	Blandville	2.89	Carrollton	0.26
Louisiana	54.5	− 4.2	Donaldsonville	89	10	2 stations	17	24	1.15	−2.28	Plain Dealing	5.21	Paradis	0.25
Maryland-Delaware	41.3	− 3.0	Westernport, Md.	76	6†	Oakland, Md.	− 1	27	0.58	−1.65	Cumberland, Md.	1.33	State Sanatorium, Md.	0.07
Michigan	35.3	− 0.8	3 stations	69	9†	Ewen	− 6	26	0.87	−1.64	Howard City	1.99	Kalamazoo	0.10
Minnesota	36.1	+ 6.8	2 stations	72	3†	Cloquet	3	23	0.14	−0.95	Hallock	0.50	Moose Lake	0.00
Mississippi	51.9	− 3.3	2 stations	81	7†	Moorhead	18	24	1.58	−1.63	Okolona	3.42	Collins	0.43
Missouri	46.1	+ 1.5	Warsaw	80	4	Warsaw	8	24	1.05	−1.46	Hollister	7.75	Chillicothe (2)	0.00
Montana	40.3	+ 7.4	Flatwillow	81	2	Bowen	6	18	0.23	−0.63	Como	1.83	20 stations	0.00
Nebraska	44.2	+ 7.6	2 stations	83	4	2 stations	11	1†	0.51	−0.16	Upland	1.90	8 stations	T.
Nevada	43.4	+ 3.4	Las Vegas	86	4	Quinn River Ranch	1	20	0.52	−0.14	Owyhee	1.62	Mina	0.00
New England	33.5	− 3.6	Patten, Me.	70	1	Van Buren, Me.	−20	28	0.96	−2.36	Bar Harbor, Me.	2.16	Block Island, R. I.	0.19
New Jersey	39.8	− 3.1	2 stations	68	10†	Culvers Lake	2	26	0.56	−2.87	Atlantic City	1.15	Lakewood	0.18
New Mexico	45.6	+ 2.8	Carrizozo	90	4†	Schuster Springs	0	19	0.29	−0.42	Meek	3.96	46 stations	0.00
New York	33.8	− 3.9	Mount Hope	68	6	Moira	−16	27	1.01	−1.84	Adams Center	3.20	Bedford Hills	T.
North Carolina	46.7	− 2.8	Statesville	81	7	2 stations	12	25	0.92	−1.75	Hatteras	2.43	Altapass	0.10
North Dakota	36.7	+10.1	Mott	77	9	Marstomoor	− 7	27	0.14	−0.44	Steele	0.41	5 stations	0.00
Ohio	38.7	− 2.2	Summerfield	80	10	Philo (2)	5	25	0.54	−2.01	Hillhouse	2.28	Kinton	T.
Oklahoma	51.9	+ 1.3	2 stations	89	8†	Vinita	18	2†	1.71	−0.42	Wagoner	4.60	Altus	0.14
Oregon	44.8	+ 2.9	Riddle	79	13	Sunrise Valley	0	20	4.04	−1.44	Brookings	16.95	Fort Rock	0.43
Pennsylvania	37.6	− 3.0	Beaver Dam	69	5†	Ebensburg	− 5	27	0.63	−2.10	2 stations	1.37	Center Hall	0.12
Porto Rico	76.8	0.0	Humacas	97	9	Aibonito	52	15†	8.98	1.08	Arecibo	24.05	Hac. Isadora	1.24
South Carolina	50.4	− 3.4	St. Matthews	83	7	Mountain Rest	16	25†	0.82	−1.44	Cheraw	2.46	Ferguson	0.20
South Dakota	40.0	+ 8.2	2 stations	82	4	2 stations	4	1†	0.21	−0.39	Dowling	1.22	9 stations	0.00
Tennessee	46.9	− 1.4	4 stations	78	5†	Tazewell	9	25	1.08	−2.44	Palmetto	2.27	Sevierville	0.04
Texas	58.3	+ 1.1	La Pryor	97	4	Eastland	18	20	1.04	−1.19	Kaufmann	4.23	9 stations	T.
Utah	40.1	+ 3.0	St. George	82	3	Black's Fork	− 4	27	0.80	−0.30	Utah Experiment Station.	2.50	11 stations	0.00
Virginia	43.2	− 2.9	North Holston	78	8	Mount Weather	11	25	0.57	−1.85	Ivor	1.45	Randolph	0.10
Washington	44.5	+ 4.2	Vashon Island	78	21	Hatton	11	19	2.86	−2.38	Quiniault	10.03	Trinidad	0.38
West Virginia	39.6	− 3.4	Union	78	10	Parsons	0.00	25	0.89	−1.70	Pickens	3.65	Upper Tract	0.05
Wisconsin	36.4	+ 3.3	Racine	70	17	Long Lake	− 6	26	0.34	−1.47	Plum Island	1.70	New Richmond	T.
Wyoming	37.7	+ 6.1	Ft. Laramie	78	8	Fox Park	− 8	18	0.41	−0.24	Kendall	1.85	4 stations	0.00

† Other dates also.

EXPLANATION OF TABLES AND CHARTS.

(See the REVIEW for July, 1917, p. 388.)

TABLE I.—*Climatological data for Weather Bureau Stations, November, 1917.*

Districts and stations.	Elevation of instruments: Barometer above sealevel.	Elevation: Thermometer above ground.	Elevation: Anemometer above ground.	Pressure: Station, reduced to mean of 24 hours.	Pressure: Sealevel, reduced to mean of 24 hours.	Pressure: Departure from normal.	Temperature: Mean max.+mean min.÷2.	Temperature: Departure from normal.	Temperature: Maximum.	Temperature: Date.	Temperature: Mean maximum.	Temperature: Minimum.	Temperature: Date.	Temperature: Mean minimum.	Temperature: Greatest daily range.	Mean wet thermometer.	Mean temperature of the dew point.	Mean relative humidity.	Precipitation: Total.	Precipitation: Departure from normal.	Precipitation: Days with 0.01 inch or more.	Wind: Total movement.	Wind: Prevailing direction.	Wind: Maximum velocity: Miles per hour.	Wind: Maximum velocity: Direction.	Wind: Maximum velocity: Date.	Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness, tenths.	Total snowfall.	Snow on ground at end of month.
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F		°F	°F.		°F	°F.	°F.	°F.	%	In.	In.		Miles								0-10	In.	In.
New England.							**36.7**	**−3.4**										**70**	**0.85**	**−2.8**										**4.5**		
Eastport	76	67	85	29.86	29.94	−0.07	32.4	−4.4	53	6	38	6	28	26	22	30	28	85	1.72	−2.4	9	9,126	nw.	38	nw.	7	8	7	15	6.5	1.0	T.
Greenville	1,070	6	....	28.79	29.99	......	27.2	......	50	18	34	−4	28	20	29	....	....	....	1.26	......	9	......	......	....	......	....	9	5	16	....	9.2	....
Portland, Me.	103	82	117	29.90	30.03	− .01	34.6	−3.0	58	6	42	10	27	27	27	29	21	62	0.82	−3.0	4	6,902	nw.	36	nw.	19	20	3	7	3.9	2.9	1.4
Concord	288	70	79	29.72	30.04	− .02	33.8	−3.0	65	18	43	7	30	24	40	....	....	....	0.85	−2.5	3	4,469	nw.	28	nw.	26	19	5	6	3.4	4.4	0.7
Burlington	404	11	48	29.64	30.10	+ .05	30.0	−3.7	50	18	37	1	27	23	22	....	....	....	0.95	−1.6	7	7,299	n.	36	s.	30	5	9	16	6.7	5.0	0.3
Northfield	876	12	60	......	......	......	......	......	....	....	....	....	....	....	....	....	....	....	......	......	....	......	......	....	......	....	....	....	....	....	....	....
Boston	125	115	188	29.89	30.03	− .02	39.4	−1.8	65	18	47	13	27	32	26	33	26	64	0.59	−3.5	3	7,836	nw.	33	nw.	26	16	7	7	4.2	2.2	T.
Nantucket	12	14	90	30.00	30.01	− .04	40.2	−5.0	56	18	46	18	27	35	18	37	32	76	0.62	−2.7	4	10,710	nw.	42	ne.	16	11	11	8	5.3	1.0	....
Block Island	26	11	46	30.00	30.03	− .03	40.3	−5.0	55	18	46	17	27	35	19	37	33	75	0.19	−3.7	2	14,390	nw.	50	nw.	26	17	3	10	4.5	T.	....
Narragansett Pier	.....	9	....	......	......	......	38.0	−4.3	61	15	48	10	27	28	29	....	....	....	0.34	......	3	......	nw.	....	......	....	22	3	5	....	2.0	....
Providence	160	215	251	29.85	30.03	− .04	37.7	−2.7	63	18	45	12	27	30	25	32	26	68	0.31	−3.6	4	9,771	nw.	48	nw.	26	17	7	6	3.6	2.6	T.
Hartford	159	122	140	29.89	30.07	− .01	37.4	−2.1	64	6	46	13	27	29	30	32	26	67	1.37	−2.4	5	4,733	nw.	30	nw.	18	18	6	6	3.5	0.4	T.
New Haven	106	117	155	29.95	30.08	+ .01	39.4	−1.9	61	6	48	15	27	31	24	33	25	61	1.08	−2.5	5	6,716	nw.	32	nw.	26	17	6	7	3.8	0.6	T.
Middle Atlantic States.							**41.7**	**−2.5**										**69**	**0.67**	**−2.2**										**4.4**		
Albany	97	102	115	29.99	30.10	+0.02	35.4	−3.0	57	18	43	10	27	28	25	31	26	72	0.93	−1.9	4	5,226	nw.	24	s.	28	14	5	11	5.3	0.5	T.
Binghamton	871	10	69	29.16	30.12	+ .03	34.8	−2.8	60	6	43	11	27	27	35	....	....	....	0.81	−1.5	9	3,881	nw.	26	n.	18	8	9	13	6.1	1.1	T.
New York	314	414	454	29.73	30.08	− .01	41.2	−2.8	63	15	48	18	27	34	23	35	28	62	0.68	−2.8	4	12,519	nw.	56	nw.	18	16	7	7	4.1	0.3	....
Harrisburg	374	94	104	29.74	30.15	+ .04	41.2	−0.5	65	6	48	21	27	34	33	35	28	64	0.45	−1.9	6	4,852	nw.	24	nw.	25	16	5	9	4.4	0.1	....
Philadelphia	117	123	190	29.99	30.12	+ .02	43.4	−1.5	65	6	51	23	27	36	25	38	31	65	0.86	−2.2	4	6,748	nw.	31	n.	6	17	7	6	3.6	2.0	T.
Reading	325	81	98	29.77	30.14	......	40.8	......	65	18	49	19	27	33	30	35	29	68	0.85	−2.3	6	4,876	nw.	27	n.	16	14	7	9	4.4	0.4	....
Scranton	805	111	119	29.25	30.13	+ .04	36.8	−2.3	60	18	45	15	27	29	32	32	28	76	0.89	−1.4	8	4,626	nw.	30	nw.	18	7	13	10	6.2	1.6	....
Atlantic City	52	37	48	30.05	30.11	+ .01	41.8	−3.7	65	18	50	18	27	34	29	37	32	70	1.15	−2.1	4	4,990	nw.	19	n.	7	17	8	5	3.4	0.3	....
Cape May	18	13	49	30.12	30.14	+ .04	43.2	−4.2	64	10	50	21	27	36	22	....	....	....	0.30	−2.9	3	6,021	n.	28	nw.	26	16	6	8	3.3	1.0	....
Sandy Hook	22	10	57	30.06	30.08	......	41.8	......	59	18	47	21	27	36	19	38	33	74	0.47	......	3	12,010	nw.	49	nw.	6	17	6	7	3.9	0.2	....
Trenton	190	159	183	29.89	30.10	......	40.6	......	65	18	49	19	27	32	28	35	29	68	1.02	−2.4	4	7,521	nw.	31	nw.	26	17	6	7	3.4	0.3	....
Baltimore	123	100	113	30.00	30.14	+ .03	44.6	−1.2	70	10	52	23	27	37	29	38	30	61	0.52	−2.4	4	4,362	nw.	24	n.	26	14	10	6	4.4	2.0	....
Washington	112	62	85	30.01	30.14	+ .02	42.8	−2.2	70	18	52	20	27	33	38	36	30	67	0.53	−2.2	5	4,566	nw.	30	nw.	26	14	9	7	4.4	2.5	....
Lynchburg	681	153	188	29.39	30.15	+ .02	45.2	−0.9	72	18	57	23	27	34	42	38	31	66	0.25	−2.5	2	3,807	nw.	23	n.	25	17	4	9	4.9	T.	....
Norfolk	91	170	205	30.03	30.13	+ .02	47.8	−3.4	70	10	54	26	26	41	27	42	36	70	0.59	−2.1	5	8,437	n.	30	n.	4	16	4	10	4.2	0.0	....
Richmond	144	11	52	29.99	30.15	+ .03	44.4	−4.4	73	10	55	21	25	34	38	38	33	72	0.44	−2.0	4	4,365	sw.	21	nw.	16	13	7	10	4.7	T.	....
Wytheville	2,293	49	55	27.74	30.18	+ .05	41.2	−1.8	65	7	51	19	24	32	35	36	33	80	0.39	−2.6	6	4,298	nw.	25	nw.	16	15	3	12	4.8	T.	....
South Atlantic States.							**51.6**	**−2.5**										**72**	**0.70**	**−1.9**										**3.2**		
Asheville	2,255	70	84	27.79	30.20	+0.06	44.2	−0.9	66	7	54	19	25	34	34	37	32	72	0.27	−3.0	6	5,440	nw.	28	n.	16	15	7	8	4.1	T.	....
Charlotte	773	153	161	29.30	30.16	+ .03	49.2	−1.2	73	7	58	24	25	40	27	41	34	63	0.75	−2.1	5	6,499	ne.	35	nw.	22	14	6	10	4.2	0.0	....
Hatteras	11	12	50	30.09	30.10	− .01	51.4	−5.3	70	11	57	32	25	46	22	48	45	84	2.43	−2.2	5	10,426	n.	35	nw.	25	11	11	8	5.0	0.0	....
Manteo	12	5	42	......	......	......	49.2	......	70	12	59	26	27	39	....	....	....	....	1.22	−3.4	2	......	ne.	....	......	....	21	0	9	....	0.0	....
Raleigh	376	103	110	29.74	30.15	+ .02	47.9	−2.3	75	11	57	23	25	39	31	41	34	67	1.46	−0.9	5	4,949	n.	20	nw.	15	15	7	8	3.8	0.0	....
Wilmington	78	81	91	30.06	30.15	+ .03	51.4	−2.7	76	12	62	27	25	41	34	43	38	70	0.66	−1.8	4	4,303	n.	27	sw.	22	24	1	5	2.4	0.0	....
Charleston	48	11	92	30.10	30.15	+ .03	54.4	−3.7	75	19	63	32	25	46	27	48	43	74	0.31	−2.6	4	6,347	n.	26	ne.	4	23	3	4	2.2	0.0	....
Columbia, S. C.	351	41	57	29.78	30.17	+ .05	51.5	−2.3	75	7	62	26	26	41	33	43	36	67	0.92	−1.3	5	4,030	ne.	24	sw.	21	20	3	6	3.1	0.0	....
Augusta	180	62	77	29.96	30.16	+ .03	51.7	−2.2	76	7	64	27	25	40	37	45	41	80	1.22	−1.7	6	3,302	nw.	20	nw.	24	19	5	6	2.9	0.0	....
Savannah	65	150	194	30.09	30.16	+ .04	56.0	−1.5	75	7	66	30	25	46	28	48	41	73	0.75	−1.6	4	7,802	n.	33	w.	22	23	4	3	2.1	0.0	....
Jacksonville	43	200	245	30.10	30.15	+ .05	58.0	−3.3	76	11	67	32	25	49	28	50	45	72	0.23	−2.0	5	9,151	n.	43	sw.	22	20	6	4	2.5	0.0	....
Florida Peninsula.							**66.7**	**−3.9**										**70**	**0.24**	**−2.0**										**3.6**		
Key West	22	10	64	30.07	30.09	+0.07	70.3	−4.0	79	13	75	56	25	66	14	63	60	73	0.28	−2.1	4	8,841	ne.	44	sw.	23	14	12	4	3.8	0.0	....
Miami	25	71	79	30.08	30.11	......	67.0	−5.0	80	1	74	42	25	60	25	60	56	70	0.24	−2.3	4	7,672	nw.	31	ne.	4	15	8	7	4.0	0.0	....
Sand Key	23	39	72	30.04	30.07	+ .05	70.8	......	78	1	74	56	25	68	11	64	60	69	0.37	......	5	14,825	ne.	48	ne.	3	13	12	5	4.0	0.0	....
Tampa	35	79	96	30.11	30.15	+ .07	62.8	−2.6	78	19	72	36	25	54	25	54	48	67	0.20	−1.5	2	5,329	n.	26	w.	22	20	6	4	2.6	0.0	....
East Gulf States.							**53.9**	**−1.8**										**65**	**1.36**	**−2.1**										**3.0**	.....	
Atlanta	1,174	190	216	28.92	30.18	+0.05	51.3	−0.6	73	8	60	25	25	43	25	43	36	63	1.51	−1.9	6	7,398	nw.	34	nw.	24	16	5	9	3.7	T.	....
Macon	370	78	87	29.77	30.18	+ .05	51.5	−1.8	75	7	64	27	26	39	38	43	38	70	1.65	−1.4	5	3,865	nw.	23	nw.	24	19	5	6	3.1	0.0	....
Thomasville	273	49	58	29.87	30.17	+ .05	55.9	−2.6	80	8	68	29	25	44	33	45	38	62	0.61	−2.0	3	3,058	nw.	18	sw.	22	22	3	5	2.5	0.0	....
Pensacola	56	149	185	30.13	30.19	+ .08	57.0	−2.6	76	7	65	33	24	49	29	49	42	65	1.11	−2.6	3	9,173	n.	35	sw.	19	19	8	3	2.3	0.0	....
Anniston	741	9	57	29.40	30.22	+ .10	49.2	−2.7	74	8	62	24	25	36	39	....	....	....	1.85	−1.6	7	3,432	nw.	20	nw.	22	18	4	8	3.4	T.	....
Birmingham	700	11	48	29.44	30.23	+ .11	51.8	−2.3	74	8	62	28	24	41	37	43	36	64	1.55	−1.8	4	3,961	n.	22	se.	28	18	4	8	3.7	0.0	....
Mobile	57	125	161	30.13	30.19	+ .08	56.6	−0.9	76	8	67	33	24	47	33	48	41	66	1.43	−2.3	3	6,436	n.	27	nw.	22	17	9	4	3.0	0.0	....
Montgomery	223	100	112	29.95	30.21	+ .09	53.6	−2.1	75	8	64	30	25	43	32	45	38	64	1.87	−1.3	3	4,246	n.	22	s.	1	19	5	6	2.9	0.0	....
Corinth	469	6	....	......	......	......	49.0	......	78	8	63	22	24	35	52	....	....	....	1.30	......	4	......	n	....	s.	....	12	10	8	....	0.0	....
Jackson	304	5	....	......	......	......	52.8	......	79	7	69	24	25	37	49	....	....	....	1.76	......	2	......	n.	....	......	....	17	6	7	....	0.0	....
Meridian	375	85	93	29.80	30.21	+ .09	52.1	−1.1	75	8	65	27	25	39	40	43	37	68	2.37	−1.8	5	5,250	ne.	24	nw.	22	18	6	6	3.1	0.0	....
Vicksburg	247	65	74	29.96	30.24	+ .12	54.8	−1.1	76	11	65	29	24	44	33	46	37	61	0.71	−3.5	4	4,026	nw.	23	nw.	22	21	4	5	2.7	0.0	....
New Orleans	51	76	84	30.15	30.21	+ .11	59.0	−1.6	78	10	68	38	24	50	25	50	44	66	0.34	−3.4	2	4,383	nw.	21	nw.	22	21	7	2	2.1	0.0	....
West Gulf States.							**57.8**	**+1.4**										**66**	**1.87**	**−1.3**										**3.1**		
Shreveport	249	77	93	29.96	30.24	+0.13	55.1	−0.2	78	10	67	30	15	43	36	46	39	63	1.14	−2.9	3	4,103	se.	29	nw.	22	20	5	5	3.0	0.0	....
Bentonville	1,303	11	44	28.61	30.21	+ .10	48.4	+1.7	76	10	60	16	24	37	40	....	....	....	6.22	+3.2	7	3,655	nw.	24	nw.	22	17	5	8	3.8	0.0	....
Fort Smith	457	79	94	29.71	30.20	+ .09	51.5	+1.6	77	10	63	25	24	40	39	44	36	64	2.05	−1.2	7	5,212	s.	32	nw.	22	18	3	9	3.5	0.0	....
Little Rock	357	139	147	29.82	30.21	+ .09	52.9	+1.4	76	7	63	28	24	42	33	45	38	64	2.07	−2.5	5	5,255	nw.	33	nw.	22	15	6	9	4.7	0.0	....
Brownsville	57	4	26	......	......	......	68.7	......	88	11	81	41	20	56	41	....	....	....	0.29	......	1	......	ne.	....	......	....	....	....	....	....	....	....
Corpus Christi	20	69	77	30.19	30.21	+ .14	66.4	+3.0	84	21	74	47	20	59	34	60	57	78	0.58	−1.8	1	5,913	se.	34	se.	27	18	9	3	3.1	0.0	....
Dallas	512	109	117	29.67	30.22	......	57.0	......	83	10	69	35	24	45	36	....	....	....	1.99	......	4	5,661	se.	35	nw.	22	21	3	6	2.9	0.0	....
Fort Worth	670	106	114	29.47	30.20	+ .10	57.4	+2.3	83	10	70	33	20	45	40	48	40	60	1.35	−0.2	3	6,362	se.	40	nw.	22	22	4	4	2.5	0.0	....
Galveston	54	106	114	30.17	30.23	+ .14	62.6	−0.3	76	11	68	47	20	57	19	56	51	74	0.97	−3.0	3	6,536	se.	33	nw.	22	25	4	1	1.6	0.0	....
Houston	138	111	121	30.07	30.22	......	61.3	0.0	82	30	72	40	24	50	33	....	....	....	0.93	......	2	5,278	se.	28	nw.	22	24	5	1	1.9	0.0	....
Palestine	510	64	72	29.68	30.22	+ .11	57.8	+0.9	81	10	70	34	24	46	34	48	42	66	1.50	−2.1	3	4,525	se.	28	nw.	22	21	5	4	2.4	0.0	....
Port Arthur	34	58	66	30.17	30.21	......	58.2	......	80	11	69	37	15	47	31	52	48	80	1.02	......	3	5,758	e.	32	nw.	22	25	4	1	1.5	0.0	....
San Antonio	701	119	132	29.46	30.19	+ .11	63.4	+4.2	84	21	76	41	20	51	34	51	42	55	0.75	−1.0	2	5,416	ne.	32	nw.	19	22	7	1	2.0	0.0	....
Taylor	582	55	63	29.62	30.23	+ .15	59.2	+1.5	80	21	72	36	20	46	35	....	....	....	1.18	−1.5	2	5,022	s.	27	n.	22	22	5	3	2.3	0.0	....

TABLE I.—*Climatological data for Weather Bureau Stations, November, 1917*—Continued.

Districts and stations.	Elevation of instruments. Barometer above sealevel.	Thermometer above ground.	Anemometer above ground.	Pressure. Station, reduced to mean of 24 hours.	Sealevel, reduced to mean of 24 hours.	Departure from normal.	Temperature of the air. Mean max.+mean min.÷2.	Departure from normal.	Maximum.	Date.	Mean maximum.	Minimum.	Date.	Mean minimum.	Greatest daily range.	Mean wet thermometer.	Mean temperature of the dew point.	Mean relative humidity.	Precipitation. Total.	Departure from normal.	Days with 0.01 inch or more.	Wind. Total movement.	Prevailing direction.	Maximum velocity. Miles per hour.	Direction.	Date.	Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness, tenths.	Total snowfall.	Snow on ground at end of month.
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F		°F	°F.		°F	°F.	°F.	°F.	%	In.	In.		Miles								0-10	In.	In.
Ohio Valley and Tennessee.							**44.0**	**-0.6**										**73**	**0.78**	**-0.3**										**5.1**		
Chattanooga	762	189	213	29.38	30.21	+0.07	49.1	-1.2	71	7	59	26	25	39	33	41	35	66	0.77	-2.8	6	4.624	nw.	27	nw.	22	16	4	10	4.1	T.	....
Knoxville	996	93	100	29.11	30.19	+ .06	47.4	+0.3	70	7	57	22	25	38	31	41	37	74	0.47	-3.1	5	3.233	ne.	20	sw.	21	14	9	7	4.3	T.	....
Memphis	399	76	97	29.81	30.25	+ .13	51.8	+0.4	75	8	60	27	24	43	29	44	37	62	1.14	-3.4	4	4.904	n.	40	sw.	10	13	4	13	4.7	T.	....
Nashville	546	168	191	29.62	30.22	+ .10	47.9	-0.8	71	6	58	23	25	38	35	41	34	67	0 85	-3.0	4	4.851	nw.	31	nw.	22	12	7	11	4.9	T.	....
Lexington	989	193	230	29.12	30.22	+ .10	44.0	-0.7	67	6	52	16	24	36	25	....	....	....	1.03	-2.4	7	7.815	sw.	32	nw.	22	10	9	11	5.3	0.4	....
Louisville	525	219	255	29.63	30.22	+ .10	45.2	-1.1	71	6	54	22	24	36	30	39	33	69	1.35	-2.8	5	6.723	sw.	39	n.	18	12	7	11	5.3	T.	....
Evansville	431	139	175	29.73	30.22	+ .10	46.8	+1.5	72	6	55	26	25	39	29	40	35	70	2.19	-1.9	5	6.493	nw.	30	n.	18	12	7	11	5.0	0.3	....
Indianapolis	822	194	230	29.30	30.20	+ .10	43.0	+1.4	70	6	51	19	24	35	27	37	32	70	0.12	-3.4	6	6.940	sw.	32	n.	18	11	3	16	5.9	0.2	....
Terre Haute	575	96	129	29.56	30.19	......	44.2	......	70	9	52	26	24	36	28	39	35	76	0.11	......	5	5.747	sw.	32	n.	18	10	8	12	5.4	T.	....
Cincinnati	628	11	51	29.51	30.21	+ .09	41.4	+1.8	70	6	51	15	24	32	36	37	33	79	0.31	-2.9	5	4.572	sw.	29	n.	18	10	7	13	5.7	T.	....
Columbus	824	173	222	29.29	30.19	+ .08	40.3	-1.1	69	6	49	17	24	32	31	35	30	72	0.18	-2.9	4	6.523	nw.	32	nw.	18	12	6	12	4.8	0.6	....
Dayton	899	181	216	29.19	30.18	......	41.4	-0.7	69	6	51	15	24	32	31	37	34	80	0.34	-2.6	4	5.768	sw.	28	n.	18	12	7	11	5.5	0.6	....
Pittsburgh	842	353	410	29.24	30.17	+ .07	39.8	-3.1	64	6	48	19	25	32	28	34	30	74	0.28	-2.3	6	6.438	nw.	33	nw.	18	9	8	13	5.6	1.0	....
Elkins	1,940	41	50	28.08	30.22	+ .10	37.0	-2.6	64	12	49	12	26	25	41	31	28	84	1.23	-1.6	11	2.021	w.	13	w.	18	14	5	11	5.2	3.2	....
Parkersburg	638	77	84	29.54	30.21	+ .09	40.6	-2.6	67	6	50	20	25	31	36	35	32	82	0.60	-2.2	6	2.385	se.	24	sw.	18	12	6	12	5.6	2.3	....
Lower Lakes Region.							**36.1**	**-3.0**										**80**	**1.00**	**-2.0**										**6.0**		
Buffalo	767	247	280	29.28	30.14	+0.09	35.0	-4.3	53	11	40	15	25	30	20	33	31	86	1.17	-2.2	12	10,588	w.	52	w.	3	9	6	15	6.3	8.4	T.
Canton	448	10	61	29.61	30.10	......	28.0	-5.9	48	18	35	-15	27	21	24	....	....	....	1.74	-1.7	6	6,513	sw.	28	ne.	22	9	8	13	5.7	12.0	4 0
Oswego	335	76	91	29.74	30.12	+ .07	34.6	-4.5	52	18	40	11	27	29	22	32	28	79	1.34	-2.1	13	7,981	s.	29	nw.	18	3	11	16	7.1	5.8	T.
Rochester	523	97	113	29.56	30.15	+ .10	34.8	-3.1	54	22	41	11	25	29	23	31	28	80	1.14	-1.6	12	5,953	w.	26	w.	18	6	6	18	6.9	7.9	T.
Syracuse	597	97	113	29.47	30.13	+ .07	34.2	-4.5	54	18	40	11	27	28	23	31	28	82	0.91	-1.8	11	7,495	w.	37	nw.	18	5	8	17	6.9	4.7	T.
Erie	714	130	166	29.36	30.15	+ .09	37.1	-4.0	63	11	43	16	27	32	25	34	29	74	0.82	-2.8	10	9,030	sw.	37	se.	30	8	6	16	6.4	1.3	....
Cleveland	762	190	201	29.33	30.17	+ .10	38.2	-2.2	58	11	44	22	25	33	23	35	32	80	1.37	-1.4	8	8,391	sw.	49	ne.	22	11	3	16	6.1	8.5	....
Sandusky	629	62	103	29.48	30.18	+ .10	38.6	-2.2	62	17	44	19	24	33	28	35	32	77	0.79	-2.0	7	8,105	w.	48	n.	22	10	6	14	5.6	4.9	....
Toledo	628	208	243	29.49	30.19	+ .12	39.4	-0.3	67	6	47	14	24	32	32	35	31	77	0.36	-2.3	5	8,390	sw.	38	nw.	18	13	4	13	5.1	1.3	....
Fort Wayne	856	113	124	29.25	30.20	......	39.3	-1.3	68	6	47	14	24	31	33	35	31	79	0.23	......	5	4,799	sw.	28	nw.	22	12	7	11	5.1	0.3	....
Detroit	730	218	245	29.36	30.17	+ .11	38.4	-0.2	65	10	45	14	24	32	29	35	32	82	0.40	-2.2	6	7,751	w.	38	n.	22	13	4	13	5.2	0.9	....
Upper Lakes Region.							**36.1**	**+1.8**										**82**	**0.82**	**-1.6**										**6.1**		
Alpena	609	13	92	29.49	30.18	+0.17	32.7	-1.0	64	17	39	11	25	26	34	30	28	86	0.81	-1.8	7	7,069	nw.	40	nw.	18	10	7	13	5.7	2.0	T.
Escanaba	612	54	60	29.50	30.19	+ .16	34.4	+2.7	58	17	40	17	25	28	25	32	30	84	0.80	-1.5	4	6,253	sw.	52	ne.	22	10	7	13	5.9	2.6	0.5
Grand Haven	632	54	92	29.48	30.19	+ .15	37.2	-0.8	59	6	44	17	23	30	26	34	30	80	1.30	-1.2	8	6,907	n.	33	nw.	21	12	7	11	5.2	3.0	....
Grand Rapids	707	70	87	29.40	30.19	+ .14	38.2	+0.1	65	5	46	18	24	31	30	34	31	81	1.21	-1.3	8	3,395	nw.	19	nw.	18	11	8	11	5.3	3.6	T
Houghton	684	62	99	29.43	30.18	+ .16	34.9	+3.4	58	17	40	12	26	29	24	....	....	....	0.71	-2.1	10	6,550	w.	34	w.	14	7	6	17	7.0	3.8	0.8
Lansing	878	11	62	29.21	30.18	......	35.8	-1.0	66	5	46	10	24	26	35	31	29	87	0.82	-1.6	7	3,881	sw.	25	n.	22	12	4	14	5.3	2.7	....
Ludington	637	60	66	29.47	30.18	......	36.8	......	55	5	43	19	23	31	22	34	32	85	1.34	......	8	6,358	se.	34	sw.	19	11	3	16	5.8	6.8	T.
Marquette	734	77	111	29.38	30.20	+ .18	35.4	+3.5	67	17	41	17	26	30	25	31	28	80	1.66	-1.1	11	5,962	nw.	37	nw.	18	2	10	18	7.6	14.0	3.2
Port Huron	638	70	120	29.45	30.16	+ .11	35.5	-1.3	60	11	43	15	24	28	28	32	30	85	0.84	-1.8	6	7,653	nw.	40	ne.	22	10	7	13	5.8	2.3	1.0
Saginaw	641	48	82	29.46	30.18	......	35.6	......	65	5	44	11	24	27	35	31	29	83	1.04	-1.2	6	5,969	w.	36	n.	22	9	5	16	6.3	1.8	T.
Sault Sainte Marie	614	11	61	29.47	30.19	+ .18	31.8	+1.1	56	17	38	3	26	26	26	29	27	83	0.52	-2.4	5	6,176	nw.	33	nw.	15	7	11	12	6.4	5.2	0.3
Chicago	823	140	310	29.29	30.20	+ .13	43.0	+3.8	69	17	49	22	24	37	23	35	33	71	0.56	-1.9	6	7,728	nw.	33	nw.	21	12	4	14	5.6	1.5	....
Green Bay	617	109	144	29.50	30.18	+ .14	36.0	+3.5	64	16	43	16	26	30	31	32	29	80	0.70	-1.3	3	7,700	sw.	48	n.	22	4	8	18	7.5	0.7	....
Milwaukee	681	119	133	29.43	30.19	+ .14	40.2	+4.1	67	17	46	20	24	35	23	36	33	81	0.39	-1.6	5	6,918	w.	34	nw.	22	11	8	11	5.4	1.5	T.
Du uth	1,133	11	47	28.93	30.18	+ .14	34.4	+5.1	64	10	41	14	28	28	27	31	29	85	0.09	-1.5	3	8,207	sw.	47	nw.	21	7	6	17	7.0	0.5	T.
North Dakota.							**37.8**	**+13.3**										**80**	**0.14**	**-0.6**										**4.7**		
Moorhead	940	8	57	29.16	30.20	+0.13	36.1	+11.7	67	19	45	13	30	27	40	32	30	88	0.19	-0.8	3	5,212	se.	32	nw.	21	14	5	11	5.2	1.8	0.3
Bismarck	1,674	8	57	28.37	30.20	+ .13	40.2	+14.2	69	2	52	16	30	28	44	34	29	76	0.04	-0.6	2	5,272	nw.	45	nw.	21	14	8	8	4.4	T.	....
Devils Lake	1,482	11	44	28.54	30.16	+ .10	35.6	+13.0	62	4	45	- 2	30	26	32	31	29	86	0.32	-0.4	1	5,858	se.	42	nw.	21	12	7	11	5.2	5.0	2.0
Grand Forks	835	12	89	......	......	......	33.8	......	57	4	42	10	30	26	29	....	....	....	0.24	......	2	......	s.	31	se.	26	9	10	11	....	2.4	0.8
Williston	1,872	41	48	28.12	30.14	+ .08	39.4	+14.2	68	3	51	15	30	28	38	33	28	70	0.01	-0.6	1	3,979	sw.	44	nw.	21	16	7	7	4.0	0.1	....
Upper Mississippi Valley.							**42.2**	**+4.4**										**76**	**0.25**	**-1.6**										**5.8**		
Minneapolis	918	10	208	29.16	30.17	......	38.8	......	62	4	46	19	22	32	28	....	....	....	0.06	-1.1	2	6,795	se.	49	nw.	21	7	6	17	6.6	0.9	T.
St. Paul	837	201	236	29.26	30.19	+0.13	38.2	+7.3	61	5	45	20	22	31	28	....	....	....	0.06	-1.2	3	6,748	se.	51	nw.	21	7	9	14	6.3	0.5	T.
La Crosse	714	11	48	29.40	30.20	+ .13	38.0	+4.2	64	5	46	15	24	30	30	....	....	....	0.14	-1.4	3	3,052	se.	24	nw.	21	8	6	16	6.5	1.2	....
Madison	974	70	78	29.14	30.22	+ .16	38.2	+4.0	65	17	45	18	24	31	25	35	32	83	0.30	-1.5	4	5,996	w.	35	n.	22	8	7	15	6.4	1.8	0.2
Wausau	1,247	4	....	28.82	30.19	......	34.8	......	64	17	43	14	24	27	32	....	....	....	0.26	......	4	......	nw.	....	....	....	8	7	15	6.1	1.1	0.3
Charles City	1,015	10	49	29.10	30.21	+ .13	38.2	+5.2	65	16	47	14	24	30	33	34	31	84	0.35	-1.0	4	3,727	se.	26	nw.	21	10	8	12	6.2	3.6	T.
Davenport	606	71	79	29.54	30.21	+ .13	42.2	+4.7	72	6	50	18	24	34	33	37	34	80	0.26	-1.5	5	3,820	w.	24	w.	21	8	10	12	6.0	0.5	....
Des Moines	861	84	97	29.26	30.19	+ .11	43.0	+6.2	71	7	52	16	24	34	30	37	32	71	0.21	-1.3	4	4,329	sw.	37	nw.	21	11	6	13	5.5	0.4	....
Dubuque	698	81	96	29.46	30.24	+ .17	40.2	+4.2	66	17	48	17	24	32	33	36	32	78	0.07	-1.7	3	3,454	s.	33	n.	21	7	10	17	6.2	0.5	T.
Keokuk	614	64	78	29.52	30.22	+ .13	44.5	+4.9	74	7	53	17	24	36	31	38	33	72	0.01	-1.8	1	4,461	sw.	28	nw.	21	13	4	13	5.2	T.	....
Cairo	356	87	93	29.81	30.20	+ .08	48.2	+1.3	74	7	57	23	24	39	31	41	36	70	2.91	-1.1	6	5,194	n.	28	n.	22	11	9	10	4.9	T.	....
Peoria	609	11	45	29.54	30.21	+ .12	41.8	+4.3	70	6	51	15	24	33	36	37	34	84	0.07	-2.6	3	3,913	n.	34	nw.	21	11	8	11	5.1	T.	....
Springfield, Ill	644	10	91	29.50	30.19	+ .09	43.8	+3.1	72	7	52	18	24	35	32	38	33	73	0.25	-2.4	4	5,023	w.	30	nw.	21	11	5	14	5.6	0.8	....
Hannibal	534	74	109	29.62	30.21	+ .12	44.5	+4.0	75	7	54	13	24	35	34	....	....	....	0 08	-1.9	3	5,403	sw.	28	nw.	21	14	2	14	5.1	T.	....
St. Louis	567	265	303	29.58	30.20	+ .10	47.7	+4.3	74	7	55	24	24	40	32	41	34	66	0.78	-2.1	5	7,427	nw.	37	w.	21	11	6	13	5.6	0.1	....
Missouri Valley.							**44.8**	**+7.3**										**70**	**0.19**	**-0.9**										**4.7**		
Columbia, Mo	781	11	84	29.35	30.20	+0.11	45.4	+3.0	75	4	56	13	24	35	37	....	....	....	0.10	-2.2	4	4,779	n.	38	nw.	21	13	3	14	5.2	T.	....
Kansas City	963	161	181	29.15	30.20	+ .11	47.7	+6.2	74	4	56	24	24	39	32	39	32	62	0.06	-1.8	4	7,431	s.	66	n.	21	15	7	8	4.2	0.1	....
St. Joseph	967	11	49	29.14	30.20	......	46.4	......	75	8	56	17	24	37	34	39	32	65	0.04	......	3	4,959	s.	54	nw.	21	11	10	9	4.8	0.1	....
Springfield, Mo	1,324	98	104	28.78	30.21	+ .11	47.4	+3.0	73	10	56	20	24	38	32	39	32	64	2.61	0.0	6	6,398	s.	38	nw.	22	15	6	9	4.5	T.	....
Iola	984	11	50	29.14	30.21	+ .12	47.5	+4.5	76	9	59	17	24	36	43	....	....	....	0.05	-1.3	4	4,791	s.	30	nw.	21	14	9	7	3.7	0.0	....
Topeka	983	85	101	......	......	......	47.6	+6.0	76	9	58	21	24	37	38	....	....	....	0.05	-1.2	3	6,608	s.	46	nw.	21	15	9	6	3.8	T.	....
Drexel	1,299	10	53	28.76	30.19	......	43.5	......	71	8	54	19	28	33	35	36	32	74	0.25	......	6	6,587	sw.	38	nw.	21	13	8	9	4.6	0.5	....
Lincoln	1,189	11	84	28.88	30.17	+ .09	44.9	+6.9	75	8	57	18	28	33	43	38	32	68	0.05	-0.8	1	5,993	s.	60	nw.	21	14	6	10	4.5	0.5	....
Omaha	1,105	115	122	28.99	30.20	+ .12	45.8	+8.1	72	8	55	24	28	37	32	38	32	66	0.12	-0.9	2	4,637	s.	48	nw.	21	14	8	8	5.0	0.5	....
Valentine	2,598	47	54	27.42	30.19	+ .11	43.4	+9.7	79	4	58	14	27	29	51	36	30	70	0.07	-0.7	3	5,616	w.	32	nw.	20	13	12	5	4.4	T.	....
Sioux City	1,135	94	164	28.96	30.20	+ .12	41.8	+7.5	67	7	51	18	1	33	35	37	33	78	0.47	-0.5	5	6,346	se.	50	nw.	21	15	3	12	4.9	2.4	....
Huron	1,306	59	74	28.77	30.20	+ .12	40.2	+12.8	73	4	52	14	1	29	48	35	31	80	0.26	-0.3	5	6,173	se.	45	nw.	21	9	9	12	5.8	1.4	T.
Pierre	1,572	70	75	28.48	30.18	+ .10	43.4	+11.8	75	3	56	19	27	31	45	37	32	72	T.	-0.4	0	5,055	se.	60	nw.	21	16	3	11	4.6	0.0	....
Yankton	1,233	49	57	28.84	30.19	+ .11	42.0	+8.5	73	4	52	21	1	32	42	....	....	....	0.45	-0.3	5	4,171	nw.	35	nw.	21	7	11	12	6.1	1.7	....

TABLE I.—*Climatological data for Weather Bureau Stations, November, 1917*—Continued.

Districts and stations.	Elevation of instruments. Barometer above sealevel.	Thermometer above ground.	Anemometer above ground.	Pressure. Station, reduced to mean of 24 hours.	Sealevel, reduced to mean of 24 hours.	Departure from normal.	Temperature of the air. Mean max.+mean min.÷2.	Departure from normal.	Maximum.	Date.	Mean maximum.	Minimum.	Date.	Mean minimum.	Greatest daily range.	Mean wet thermometer.	Mean temperature of the dew point.	Mean relative humidity.	Precipitation. Total.	Departure from normal.	Days with 0.01 inch or more.	Wind. Total movement.	Prevailing direction.	Maximum velocity. Miles per hour.	Direction.	Date.	Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness, tenths.	Total snowfall.	Snow on ground at end of month.
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F		°F	°F.		°F	°F.	°F.	°F.	%	In.	In.		Miles								0–10	In.	In.
Northern Slope.							**40.7**	**+8.7**									**69**	**0.24**	**−0.4**									**4.4**				
Billings	3,140	5	....	......	......	......	43.7	......	74	3	59	20	12	29	42	....	....	....	0.14	......	3	......	sw.	....	......	....	21	6	3	....	T.	....
Havre	2,505	11	44	27.44	30.13	+0.10	41.0	+10.4	72	3	55	20	14	27	41	34	30	75	0.02	−0.8	2	4,530	sw.	35	sw.	20	16	9	5	3.6	T.	....
Helena	4,110	87	112	25.93	30.21	+ .11	40.7	+8.0	67	22	50	25	27	32	27	34	28	68	0.32	−0.4	2	4,489	sw.	40	sw.	21	19	5	6	3.7	2.5	2.2
Kalispell	2,973	48	40	27.10	30.23	+ .16	36.2	+4.2	62	21	42	23	18	30	25	34	32	86	0.51	−1.4	6	2,221	nw.	18	w.	28	4	8	18	7.5	0.6	....
Miles City	2,371	48	55	27.60	30.21	+ .14	43.7	+12.8	75	3	58	22	14	30	45	36	33	78	0.04	−0.6	1	2,981	ne.	19	s.	20	25	3	2	1.9	0.0	....
Rapid City	3,259	50	58	26.73	30.20	+ .12	45.7	+12.1	72	3	58	17	27	34	36	36	26	51	0.01	−0.4	1	6,361	w.	37	n.	17	12	14	4	4.0	T.	....
Cheyenne	6,088	84	101	24.13	30.20	+ .13	40.8	+5.9	66	4	53	15	27	29	35	32	24	56	0.40	0.0	5	8,715	w.	47	w.	30	10	15	5	4.9	3.9	....
Lander	5,372	60	68	24.80	30.29	+ .19	35.9	+7.2	58	9	48	12	16	24	32	29	22	64	1.10	+0.5	4	1,964	sw.	20	w.	29	12	9	9	6.5	5.0	....
Sheridan	3,790	10	47	26.23	30.22	......	41.8	......	70	20	57	18	12	27	46	33	27	69	0.12	......	3	2,537	s.	26	nw.	21	16	6	8	4.5	T.	....
Yellowstone Park	6,200	11	48	24.02	30.28	+ .17	36.6	+7.3	58	5	48	16	17	26	32	30	25	58	0.66	−0.8	5	4,310	s.	32	s.	30	9	15	6	5.3	1.8	....
North Platte	2,821	11	51	27.23	30.21	+ .13	45.5	+10.4	79	4	60	24	1	31	49	36	31	71	0.71	+0.3	6	4,487	w.	26	nw.	21	20	4	6	3.1	2.2	....
Middle Slope.							**48.0**	**+6.2**										**58**	**0.25**	**−0.7**										**3.7**		
Denver	5,292	106	113	24.87	30.20	+0.14	45.6	+6.4	72	3	58	21	28	33	34	35	26	53	0.03	−0.5	2	4,925	s.	38	nw.	17	13	10	7	4.1	T.	....
Pueblo	4,685	80	86	25.44	30.20	+ .15	44.8	+5.5	76	4	61	15	28	28	47	34	24	51	0.02	−0.4	1	3,565	nw.	25	w.	29	13	11	6	4.2	T.	....
Concordia	1,392	50	58	28.70	30.21	+ .13	47.3	+7.4	76	4	59	24	19	35	42	39	32	66	0.07	−0.9	1	5,189	s.	27	nw.	22	12	10	8	4.6	0.0	....
Dodge City	2,509	11	51	27.57	30.22	+ .15	48.6	+8.1	80	4	62	22	28	35	41	38	30	60	0.58	0.0	3	4,224	s.	28	s.	24	21	4	5	2.8	0.0	....
Wichita	1,358	139	158	28.72	30.18	+ .10	49.4	+5.6	75	4	60	26	19	39	34	40	32	59	0.02	−1.2	1	8,921	s.	39	s.	3	17	8	5	3.6	0.0	....
Altus	1,410	5	....	......	......	......	54.4	......	82	10	69	32	20	40	44	....	....	....	0.83	......	4	......	nw.	....	......	....	23	3	4	....	0.0	....
Muskogee	652	4	....	......	......	......	49.2	......	82	10	63	22	25	35	47	....	....	....	3.32	......	6	......	s.	....	......	....	12	3	15	....	0.0	....
Oklahoma	1,214	10	47	28.91	30.21	+ .13	52.4	+4.5	78	9	64	31	24	41	37	42	34	61	0.80	−1.4	5	8,677	s.	39	n.	22	20	5	5	2.8	0.0	....
Southern Slope.							**53.3**	**+4.8**										**51**	**0.27**	**−0.9**										**2.9**		
Abilene	1,738	10	52	28.36	30.19	+0.12	57.6	+5.0	81	21	71	31	20	44	41	45	35	50	0.16	−1.1	4	6,600	s.	28	s.	26	17	7	6	3.5	0.0	....
Amarillo	3,676	10	49	26.43	30.21	+ .16	50.8	+6.0	79	3	64	28	26	38	45	40	32	63	0.59	−0.6	4	7,489	nw.	33	nw.	18	25	3	2	2.6	0.2	....
Del Rio	944	64	71	......	......	......	......	......	....	....	....	....	....	....	....	....	....	....	......	......	....	......	......	....	......	....	....	....	....	....	......	....
Roswell	3,566	75	85	26.52	30.16	+ .13	51.4	+3.3	80	21	68	24	28	34	51	38	23	41	0.06	−1.1	2	4,339	s.	34	nw.	29	17	13	0	2.7	0.0	....
Southern Plateau.							**52.9**	**+4.0**										**45**	**0.08**	**−0.6**										**1.4**		
El Paso	3,762	110	133	26.33	30.13	+0.13	55.4	+4.5	78	8	70	34	19	41	37	42	29	40	0.04	−0.6	2	6,086	e.	28	w.	25	26	4	0	1.2	0.0	....
Santa Fe	7,013	57	66	23.38	30.17	+ .14	45.1	+6.9	63	6	55	26	28	35	27	33	22	46	0.26	−0.5	2	5,679	e.	28	se.	13	19	11	0	2.8	0.0	....
Flagstaff	6,908	8	57	23.47	30.15	+ .13	38.6	+4.0	65	23	57	10	29	20	47	....	....	....	0.01	......	1	......	sw.	34	ne.	17	25	5	0	....	0.1	....
Phoenix	1,108	76	81	28.89	30.06	+ .08	60.9	+2.2	88	4	80	34	29	42	46	46	37	53	0.00	−1.0	0	2,963	e.	14	ne.	17	26	4	0	1.1	0.0	....
Yuma	141	9	54	29.91	30.06	+ .08	64.4	+2.5	90	1	81	41	30	48	38	49	34	40	0.00	−0.3	0	3,292	n.	18	n.	17	28	2	0	0.6	0.0	....
Independence	3,910	11	42	......	......	......	......	......	....	....	....	....	....	....	....	....	....	....	......	......	....	......	......	....	......	....	....	....	....	....	......	....
Needles, Cal.	488	4	....	29.56	30.08	......	59.2	......	85	4	75	33	30	43	43	....	....	....	T.	......	0	......	nw.	....	......	....	23	2	5	....	0.0	....
Middle Plateau.							**42.8**	**+3.2**										**55**	**0.51**	**−0.4**										**4.2**		
Reno	4,532	74	81	25.61	30.20	+0.09	44.6	+3.6	72	1	58	22	21	31	40	36	28	58	0.68	−0.4	5	3,633	w.	45	w.	30	15	6	9	3.9	0.0	....
Tonopah	6,090	12	20	24.20	30.18	......	43.6	......	64	1	51	28	13	36	21	35	24	49	0.63	−0.3	3	5,347	se.	36	nw.	12	16	8	6	3.5	0.0	....
Winnemucca	4,344	18	56	25.77	30.23	+ .09	41.9	+4.4	72	2	59	9	20	25	51	32	23	56	0.25	−0.5	3	4,613	ne.	36	sw.	30	15	5	10	4.3	0.0	....
Modena	5,479	10	43	24.76	30.21	+ .13	39.0	0.0	70	2	56	13	19	22	46	30	20	56	0.16	−0.4	1	5,764	w.	36	sw.	12	14	9	7	4.4	0.1	....
Salt Lake City	4,360	163	203	25.80	30.23	+ .11	44.0	+3.6	69	3	51	30	23	37	26	37	30	63	1.31	−0.1	8	3,764	se.	32	sw.	30	11	7	12	5.3	T.	....
Grand Junction	4,602	82	96	25.56	30.19	+ .11	44.6	+4.7	73	7	57	22	28	32	34	35	22	46	0.02	−0.5	1	4,592	se.	29	s.	13	16	10	4	3.5	0.0	....
Northern Plateau.							**43.4**	**+4.8**										**68**	**1.00**	**−0.4**										**6.1**		
Baker	3,471	48	53	26.59	30.23	+0.07	40.4	+5.5	64	2	51	17	26	30	32	36	30	69	0.92	−0.3	5	4,692	se.	36	s.	3	10	7	13	5.7	1.5	....
Boise	2,739	78	86	27.35	30.26	+ .09	44.4	+4.8	72	3	55	22	20	34	34	38	31	64	1.17	+0.3	4	2,617	nw.	21	se.	30	12	7	11	5.2	0.0	....
Lewiston	757	40	48	29.40	30.23	+ .11	45.6	+4.7	65	11	55	26	19	36	37	....	....	....	1.23	−0.1	8	1,267	e.	16	ne.	27	9	5	16	6.4	0.0	....
Pocatello	4,477	60	68	25.64	30.23	+ .09	41.6	+5.3	69	2	52	21	18	32	40	35	29	68	0.67	+0.1	9	5,106	se.	38	s.	30	8	9	13	6.0	T.	....
Spokane	1,929	101	110	28.13	30.22	+ .12	42.1	+4.8	61	20	49	25	19	35	32	39	36	81	0.95	−1.4	7	3,081	e.	24	sw.	28	6	5	19	7.3	0.0	....
Walla Walla	991	57	65	29.11	30.20	+ .07	46.6	+3.7	68	21	55	30	18	39	34	42	38	60	1.05	−1.1	6	2,425	s.	14	sw.	28	12	4	14	6.0	0.0	....
North Pacific Coast Region.							**49.9**	**+4.4**										**86**	**4.43**	**−2.4**										**6.7**		
North Head	211	11	56	29.85	30.08	+0.03	52 2	+4.5	65	1	56	42	30	48	15	50	49	91	4.99	−1.3	18	11,518	se.	58	se.	4	7	6	17	6.7	0.0	....
North Yakima	1,071	4	....	......	......	......	43.0	......	66	21	53	22	19	33	34	....	....	....	1.28	......	5	......	nw.	....	......	....	9	7	14	....	4.0	3.0
Port Angeles	53	8	48	30.07	30.10	......	45.8	......	60	20	51	32	26	40	16	....	....	....	1.81	−2.6	16	3,162	s.	25	w.	24	0	6	24	8.9	0.0	....
Seattle	125	215	250	30.00	30.13	+ .09	49.6	+5.1	65	21	55	34	26	44	21	48	45	85	2.70	−3.2	17	5,154	se.	40	s.	27	0	7	23	5.2	0.0	....
Tacoma	213	113	120	29.89	30.12	+ .08	48.8	+4.7	67	21	55	33	26	43	24	48	47	92	3.31	−5.2	12	2,794	sw.	18	w.	28	1	8	21	8.2	0.0	....
Tatoosh Island	109	7	57	29.96	30.06	+ .09	49.4	+3.5	60	10	53	38	30	46	11	48	47	90	7.66	−4.4	23	13,430	e.	58	s.	20	7	8	15	6.7	T.	....
Medford	1,425	4	....	......	......	......	46.6	......	73	1	58	24	19	35	42	....	....	....	4.26	......	11	......	se.	....	......	....	5	7	18	....	0.0	....
Portland, Oreg.	153	68	106	29.96	30.12	+ .02	50.6	+5.0	66	21	57	34	19	44	23	47	43	76	4.24	−2.2	12	3,625	se.	25	sw	12	5	13	12	6.1	0.0	....
Roseburg	510	9	57	29.58	30.14	+ .02	49.0	+3.4	71	1	58	35	19	40	32	46	43	83	6.27	+1.9	11	1,592	nw.	17	sw.	29	8	14	8	5.1	0.0	....
Middle Pacific Coast Region.							**55.3**	**+2.2**										**72**	**1.76**	**−1.4**										**4.8**		
Eureka	62	73	89	30.08	30.15	+0.04	52.8	+1.8	73	9	60	39	19	45	28	50	47	84	6.43	0.8	12	4,242	se.	32	se.	11	9	8	13	5.9	0.0	....
Mount Tamalpais	2,375	11	18	27.66	30.14	+ .05	53.5	+2.9	73	2	59	40	6	48	22	46	38	64	1.37	−2.3	7	10,042	nw.	58	nw.	5	14	7	9	4.6	0.0	....
Point Reyes Light	490	7	18	29.59	30.11	......	56.4	+3.4	78	21	62	47	1	51	25	....	....	....	1.57	......	10	9,861	nw.	48	sw.	30	10	2	18	6.1	0.0	....
Red Bluff	332	50	56	29.78	30.15	+ .04	54.4	+1.0	78	1	64	38	21	44	35	48	43	69	1.14	−2.0	6	3,215	nw.	25	se.	30	15	5	10	4.4	0.0	....
Sacramento	69	106	117	30.09	30.16	+ .07	55.2	+1.8	80	1	67	36	27	44	32	49	43	68	0.25	−1.9	4	3,717	n.	24	s.	30	16	9	5	3.5	0.0	....
San Francisco	155	209	213	29.98	30.15	+ .06	58.9	+3.4	72	20	65	48	27	52	21	53	48	74	0.81	−1.7	6	3,955	n.	34	sw.	30	13	6	11	4.9	0.0	....
San Jose	141	12	110	29.99	30.14	......	55.8	+1.4	76	21	68	35	20	43	41	....	....	....	0.54	−1.4	4	2,186	nw.	22	s.	30	13	10	7	4.0	0.0	....
South Pacific Coast Region.							**60.0**	**+2.9**										**66**	**0.32**	**−1.0**										**3.1**		
Fresno	327	89	98	29.79	30.16	+0.10	56.7	+2.1	83	1	69	38	25	44	35	49	41	61	0.35	−0.7	3	3,205	nw.	27	nw.	12	20	7	3	2.8	0.0	....
Los Angeles	338	159	191	29.74	30.11	+ .09	63.7	+5.3	87	19	74	48	28	54	32	53	46	64	0.36	−1.1	1	3,728	ne.	19	sw.	6	17	11	2	3.3	0.0	....
San Diego	87	62	70	30.00	30.09	+ .07	60.8	+1.8	85	19	69	46	29	52	29	54	49	74	0.08	−0.8	2	3,329	nw.	25	s.	6	18	10	2	2.8	0.0	....
San Luis Obispo	201	32	40	29.93	30.15	+ .09	58.6	+2.3	89	21	73	34	27	44	45	50	43	66	0.47	−1.2	3	2,230	nw.	22	n.	20	17	7	6	3.4	0.0	....
West Indies.																																
San Juan, P. R.	82	8	54	29.84	29.92	+0.02	77.9	......	89	11	83	70	30	73	16	73	72	83	10.09	......	18	8,437	ne.	50	ne.	28	3	20	7	5.6	0.0	....
Panama Canal.																																
Balboa Heights	118	7	97	29.75	29.87	......	78.0	......	90	27	84	71	6	72	17	74	73	93	13.77	+3.4	24	4,627	nw.	28	n.	24	0	13	17	7.3	0.0	....
Colon	25	30	97	29.84	29.87	......	77.5	......	85	9	81	72	25	74	11	75	74	89	20.49	−1.0	21	7,651	nw.	42	nw.	24	2	8	20	7.9	0.0	....
Alaska.																																
Juneau	80	11	49	......	......	......	37.4	+2.3	54	19	42	8	30	33	18	36	33	84	16.77	+8.9	26	4,433	se.	32	e.	27	2	2	26	9.0	23.0	6.5

TABLE 2.—*Accumulated amounts of precipitation for each 5 minutes, for the principal storms in which the rate of fall equaled or exceeded 0.25 inch in any 5 minutes, or 0.80 in 1 hour, during November, 1917, at all stations furnished with self-registering gages.*

Stations.	Date.	Total duration.		Total amount of precipitation.	Excessive rate.		Amount before excessive rate began.	Depths of precipitation (in inches) during periods of time indicated.													
		From—	To—		Began—	Ended—		5 min.	10 min.	15 min.	20 min.	25 min.	30 min.	35 min.	40 min.	45 min.	50 min.	60 min.	80 min.	100 min.	120 min.
Abilene, Tex	28			0.10														0.06			
Albany, N. Y	22			0.68														0.17			
Alpena, Mich	21			0.38														0.05			
Amarillo, Tex	17-18			0.44														*			
Anniston, Ala	20			0.59														0.46			
Asheville, N. C	30			0.13														0.06			
Atlanta, Ga	20			0.58														0.35			
Atlantic City, N. J	30			0.89														0.52			
Augusta, Ga	30			0.42														0.33			
Baker, Oreg	28-29			0.44														*			
Baltimore, Md	30			0.24														0.05			
Bentonville, Ark	27			4.97														0.57			
Binghamton, N. Y	22			0.58														0.26			
Birmingham, Ala	28			0.80														0.55			
Bismarck, N. Dak	23			0.04														*			
Block Island, R. I	28			0.14														0.07			
Boise, Idaho	28			0.48														0.12			
Boston, Mass	22			0.39														0.10			
Buffalo, N. Y	21			0.11														0.05			
Burlington, Vt	22-23			0.55														*			
Cairo, Ill	11			1.12														0.44			
Canton, N. Y	22-23			0.85														*			
Charles City, Iowa	26			0.24														*			
Charleston, S. C	30			0.19														0.19			
Charlotte, N. C	29			0.27														0.12			
Chattanooga, Tenn	28-29			0.28														0.15			
Cheyenne, Wyo	26-27			0.34														*			
Chicago, Ill	21-22			0.34														*			
Cincinnati, Ohio	27			0.12														0.05			
Cleveland, Ohio	1			0.67														*			
Columbia, Mo	26			0.06														0.02			
Columbia, S. C	13			0.52														0.21			
Columbus, Ohio	27			0.12														*			
Concord, N. H	22			0.56														*			
Concordia, Kans	17			0.07														0.01			
Corpus Christi, Tex	18			0.58														0.44			
Dallas, Tex	28	12:05 a. m.	6.03 a. m.	1.82	12:29 a. m.	12:52 a. m.	0.09	0.17	0.28	0.39	0.47	0.51									
Davenport, Iowa	26			0.20														*			
Dayton, Ohio	27			0.25														*			
Denver, Colo	14-15			0.03														*			
Des Moines, Iowa	9			0.14														0.07			
Detroit, Mich	21-22			0.24														*			
Devils Lake, N. Dak	26			0.32														*			
Dodge City, Kans	17-18			0.48														*			
Drexel, Nebr	9			0.14														*			
Dubuque, Iowa	26			0.05														*			
Duluth, Minn	26-27			0.07														*			
Eastport, Me	23			0.59														0.14			
Elkins, W. Va	22			0.20														0.17			
Ellendale, N. Dak	24			0.15														*			
El Paso, Tex	14			0.02														0.02			
Erie, Pa	21-22			0.36														*			
Escanaba, Mich	21			0.51														*			
Eureka, Cal	3			1.42														0.44			
Evansville, Ind	27			0.77														0.20			
Flagstaff, Ariz	26			0.01														*			
Fort Smith, Ark	27			0.88														0.47			
Fort Wayne, Ind	21-22			0.11														*			
Fort Worth, Tex	27-28			1.26														0.54			
Fresno, Cal	5			0.23														0.13			
Galveston, Tex	18			0.60														0.48			
Grand Haven, Mich	21			0.61														0.09			
Grand Junction, Colo	14			0.02														T.			
Grand Rapids, Mich	30			0.28														0.08			
Green Bay, Wis	21-22			0.67														*			
Greenville, S. C	12			0.39														0.14			
Hannibal, Mo	10			0.06														0.02			
Harrisburg, Pa	20			0.10														0.07			
Hartford, Conn	22			0.85														0.29			
Hatteras, N. C	21			1.35														0.99			
Havre, Mont	28			0.01														0.01			
Helena, Mont	29			0.28														*			
Houghton, Mich	21			0.26														0.11			
Houston, Tex	18			0.90														0.34			
Huron, S. Dak	9			0.16														0.05			
Indianapolis, Ind	30			0.04														0.03			
Iola, Kans	16			0.01														0.01			
Jacksonville, Fla	20			0.12														0.10			
Kalispell, Mont	30			0.30														*			
Kansas City, Mo	11			0.03														0.02			
Keokuk, Iowa	10			0.01														*			
Key West, Fla	23			0.19														0.12			
Knoxville, Tenn	30			0.12														0.08			
La Crosse, Wis	26-27			0.11														*			
Lander, Wyo	13-14			0.82														*			
Lansing, Mich	21-22			0.49														*			
Lewiston, Idaho	29			0.39														0.12			
Lexington, Ky	29			0.32														0.15			
Lincoln, Nebr	26			0.05														*			
Little Rock, Ark	28			0.62														0.30			
Los Angeles, Cal	6			0.36														0.09			
Louisville, Ky	27			0.69														0.15			
Ludington, Mich	21			0.91														0.11			
Lynchburg, Va	29			0.24														0.07			
Macon, Ga	19			1.33														0.53			
Madison, Wis	21			0.12														0.08			
Marquette, Mich	24-25			0.61														*			
Memphis, Tenn	11			0.54														0.27			

* Self-register not in use. † Record partly estimated. ‡ No precipitation occurred during month.

TABLE 2.—*Accumulated amounts of precipitation for each 5 minutes, for the principal storms in which the rate of fall equaled or exceeded 0.25 inch in any 5 minutes, or 0.80 in 1 hour, during November, 1917, at all stations furnished with self-registering gages*—Continued.

Stations.	Date.	Total duration. From—	Total duration. To—	Total amount of precipitation.	Excessive rate. Began—	Excessive rate. Ended—	Amount before excessive rate began.	5 min.	10 min.	15 min.	20 min.	25 min.	30 min.	35 min.	40 min.	45 min.	50 min.	60 min.	80 min.	100 min.	120 min.
Meridian, Miss	28	2:15 p. m.	D. N. p.m.	1.26	5:32 p. m.	6:05 p. m.	0.26	0.07	0.16	0.32	0.40	0.60	0.67	0.81							
Miami, Fla	3			0.18														0.06			
Milwaukee, Wis	26-27			0.20														*			
Minneapolis, Minn	26-27			0.06														*			
Mobile, Ala	19			1.13														0.42			
Modena, Utah	7			0.16														0.13			
Montgomery, Ala	19	8:00 a. m.	7:50 p. m.	1.31	6:03 p. m.	6:23 p. m.	0.57	0.13	0.36	0.54	0.67										
Moorhead, Minn	26			0.17														*			
Mount Tamalpais, Cal	11			0.34														0.21			
Nantucket, Mass	23			0.30														0.19			
Nashville, Tenn	12			0.30														0.24			
New Haven, Conn	22			0.74														0.21			
New Orleans, La	19			0.14														0.13			
New York, N. Y	30			0.26														0.11			
Norfolk, Va	29			0.26														0.19			
North Head, Wash	3			0.67														0.28			
North Platte, Nebr	16			0.37														0.10			
Oklahoma, Okla	27			0.48														0.12			
Omaha, Nebr	10			0.06														*			
Oswego, N. Y	1-2			0.70														*			
Palestine, Tex	17			0.78														0.36			
Parkersburg, W. Va	27			0.40														0.07			
Pensacola, Fla	19			0.66														0.48			
Peoria, Ill	29			0.04														0.04			
Philadelphia, Pa	30			0.50														0.15			
Phoenix, Ariz	‡			‡																	
Pierre, S. Dak	16			T.														T.			
Pittsburgh, Pa	22			0.12														0.05			
Pocatello, Idaho	8			0.12														0.09			
Point Reyes Light, Cal	9			0.50														0.44			
Port Angeles, Wash	2			0.42														0.16			
Port Arthur, Tex	28	10:45 a. m.	12:50 p. m.	0.62	11:09 a. m.	11:26 a. m.	0.02	0.27	0.44	0.49	0.53										
Port Huron, Mich	21			0.32														0.06			
Portland, Me	22			0.59														0.09			
Portland, Oreg	29			1.18														0.27			
Providence, R. I	28			0.13														*			
Pueblo, Colo	16			0.02														*			
Raleigh, N. C	20			0.35														0.34			
Rapid City, S. Dak	14			0.01														0.01			
Reading, Pa	30			0.40														*			
Red Bluff, Cal	11			0.39														0.24			
Reno, Nev	5-6			0.44														*			
Richmond, Va	29			0.30														0.07			
Rochester, N. Y	22-23			0.40														*			
Roseburg, Oreg	29			2.55														0.39			
Roswell, N. Mex	14			0.05														0.05			
Sacramento, Cal	5			0.13														0.04			
Saginaw, Mich	21			0.46														0.10			
St. Joseph, Mo	13			0.02														0.01			
St. Louis, Mo	26			0.21														0.10			
St. Paul, Minn	26-27			0.05														*			
Salt Lake City, Utah	13			0.52														0.11			
San Antonio, Tex	17			0.70														0.61			
San Diego, Cal	6			0.07														0.04			
Sand Key, Fla	23			0.18														0.13			
Sandusky, Ohio	22-23			0.30														*			
Sandy Hook, N. J	30			0.23														0.15			
San Francisco, Cal	30			0.40														0.21			
San Jose, Cal	10			0.30														0.18			
San Luis Obispo, Cal	10			0.34														0.20			
Santa Fe, N. Mex	14			0.24														0.24			
Sault Ste. Marie, Mich	21			0.30														*			
Savannah, Ga	13			0.49														0.42			
Scranton, Pa	22			0.40														0.14			
Seattle, Wash	2			0.72														0.13			
Sheridan, Wyo	25-26			0.10														*			
Shreveport, La	18			0.40														0.24			
Sioux City, Iowa	26			0.19														*			
Spokane, Wash	30			0.28														*			
Springfield, Ill	29			0.13														*			
Springfield, Mo	27			1.49														0.19			
Syracuse, N. Y	22			0.25														*			
Tacoma, Wash	27			0.74														0.22			
Tampa, Fla	20			0.14														0.14			
Tatoosh Island, Wash	2			0.69														0.28			
Taylor, Tex	17			1.13														0.47			
Terre Haute, Ind	28-29			0.05														*			
Thomasville, Ga	19			0.36														0.33			
Toledo, Ohio	21-22			0.18														0.04			
Tonopah, Nev	6			0.56														0.12			
Topeka, Kans	17			0.03														0.01			
Trenton, N. J	30			0.67														0.36			
Valentine, Nebr	9			0.04														*			
Vicksburg, Miss	28			0.48														0.13			
Walla Walla, Wash	29			0.46														0.10			
Washington, D. C	29-30			0.26														*			
Wausau, Wis	21			0.15														*			
Wichita, Kans	16			0.02														*			
Williston, N. Dak	26			0.01														0.01			
Wilmington, N. C	29			0.32														0.16			
Winnemucca, Nev	28			0.20														*			
Wytheville, Va	14			0.18														0.08			
Yankton, S. Dak	16			0.18														0.08			
Yellowstone Park, Wyo	30			0.32														*			

* Self-register not in use. † Record partly estimated. ‡ No precipitation during month.

TABLE III—*Data furnished by the Canadian Meteorological Service, November, 1917.*

Stations.	Altitude above M. S. L.* Jan. 1, 1916.	Pressure.			Temperature.						Precipitation.		
		Station reduced to mean of 24 hours.	Sea level reduced to mean of 24 hours.	Departure from normal.	Mean max. + mean min. ÷ 2.	Departure from normal.	Mean maximum.	Mean minimum.	Highest.	Lowest.	Total.	Departure from normal.	Total snowfall.
	Feet.	*Inches.*	*Inches.*	*Inches.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	*Inches.*	*Inches.*	*Inches.*
St. Johns, N. F.	125	29.62	29.76	−0.18	39.3	+ 2.8	44.1	34.6	57	28	9.63	+4.06	4.0
Sydney, C. B. I.	48	29.80	29.84	− .11	38.0	+ 0.9	44.5	31.5	57	16	7.22	+1.78	4.0
Halifax, N. S.	88	29.77	29.88	− .13	35.6	− 1.7	42.9	28.4	56	18	2.60	−3.06	2.2
Yarmouth, N. S.	65	29.83	29.90	− .12	35.9	− 4.0	41.0	30.8	53	18	3.55	−1.01	5.7
Charlottetown P. E. I.	38	29.82	29.86	− .10	34.1	− 1.4	38.8	29.4	55	17	2.76	−1.21	6.8
Chatham, N. B.	28	29.91	29.93	− .04	29.1	− 1.9	35.2	22.9	50	− 2	2.81	−0.94	5.7
Father Point, Que.	20	29.96	29.98	+ .02	25.6	− 3.3	30.8	20.4	40	− 9	2.00	−1.11	18.4
Quebec, Que.	296	29.70	30.04	+ .02	26.0	− 3.0	31.3	20.7	40	− 1	1.47	−1.29	13.1
Montreal, Que.	187	29.86	30.08	+ .05	28.8	− 3.0	34.0	23.6	46	3	1.63	−2.11	12.0
Stonecliffe, Ont.	489	29.50	30.13	+ .12	26.1	− 3.0	35.3	23.4	50	− 6	0.56	−2.02	4.2
Ottawa, Ont.	236	29.84	30.12	+ .10	29.3	− 2.4	36.6	22.0	52	− 7	1.87	−0.67	14.7
Kingston, Ont.	285	29.78	30.11	+ .07	32.4	− 2.6	39.9	24.9	53	4	1.16	−2.08	8.3
Toronto, Ont.	379	29.72	30.15	+ .11	34.4	− 1.2	41.8	27.1	54	10	1.25	−1.89	2.1
White River, Ont.	1,244	28.78	30.14	+ .16	24.8	+ 4.3	33.8	15.9	54	−24	0.38	−1.47	3.8
Port Stanley, Ont.	592	29.51	30.17	+ .12	33.8	− 3.0	41.9	25.8	55	11	1.30	−2.07	7.4
Southampton, Ont.	656	29.41	......	......	31.9	− 3.1	38.6	25.2	53	8	2.20	−1.50	13.8
Parry Sound, Ont.	688	29.43	30.15	+ .14	29.5	− 2.6	36.7	22.6	51	− 3	3.30	−1.07	17.9
Port Arthur, Ont.	644	29.44	30.18	+ .18	32.4	+ 8.4	40.1	24.8	58	0	0.37	−0.96	1.7
Winnipeg, Man.	760	29.28	30.15	+ .11	32.9	+14.9	40.3	25.5	59	10	0.22	−0.86	2.2
Minnedosa, Man.	1,690	28.27	30.13	+ .09	35.4	+18.1	46.6	24.2	61	8	0.26	−0.74	0.4
Qu'Appelle, Sask.	2,115	27.78	30.07	+ .07	38.4	+19.6	47.8	29.0	62	13	0.20	−0.69	2.0
Medicine Hat, Alberta.	2,144	......	......	......	......	......	......	......	......	......	......	......	......
Swift Current, Sask.	2,392	27.44	30.04	+ .02	40.6	+17.4	52.8	28.4	65	10	0.00	−0.69	0.0
Calgary, Alberta.	3,428	......	......	......	......	......	......	......	......	......	......	......	......
Banff, Alberta.	4,521	......	......	......	......	......	......	......	......	......	......	......	......
Edmonton, Alberta.	2,150	......	......	......	......	......	......	......	......	......	......	......	......
Prince Albert, Sask.	1,450	28.45	30.04	+ .01	35.7	+20.3	45.5	25.9	64	5	0.02	−0.81	0.0
Battleford, Sask.	1,592	28.25	30.02	.00	38.1	+21.8	50.3	26.0	68	6	0.18	−0.40	1.8
Kamloops, B. C.	1,262	28.86	30.18	+ .22	42.1	+ 8.7	48.0	36.3	55	21	0.08	−1.38	T.
Victoria, B. C.	230	29.83	30.09	+ .10	47.8	+ 4.6	52.3	43.3	61	37	2.28	−4.69	0.0
Barkerville, B. C.	4,180	26.65	29.99	+0.09	35.7	+12.1	42.3	29.2	50	12	4.36	+1.07	5.0
Hamilton, Bermuda.	151	29.88	30.04	− .01	67.2	− 1.5	71.9	62.5	80	53	3.06	−1.32	0.0

* See Explanation of Tables in this REVIEW for July, 1917, p. 388.

Chart I. Hydrographs of Several Principal Rivers, November, 1917.

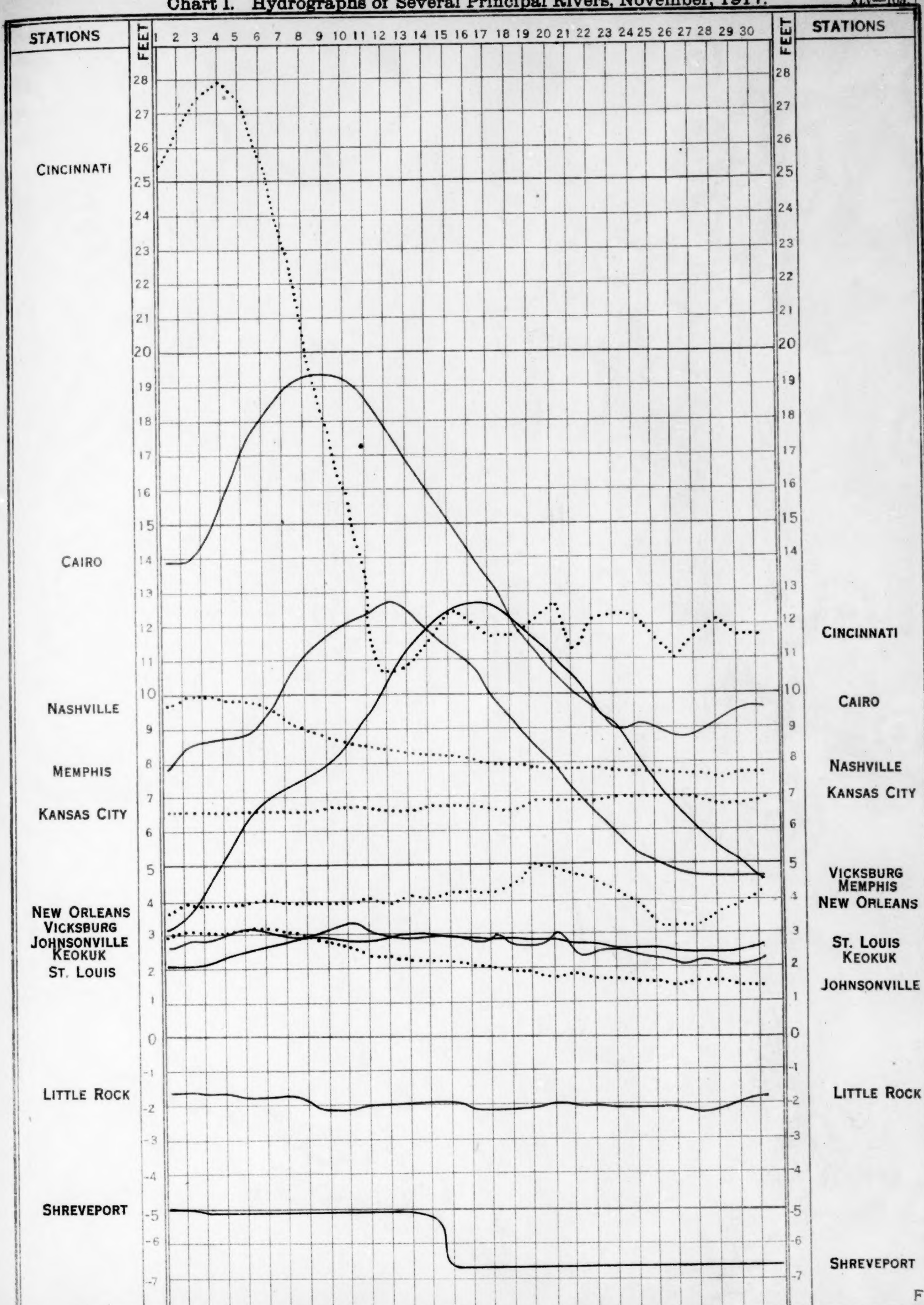


Chart II. Tracks of Centers of High Areas, November, 1917.
(Plotted by Charles A. Donnel.)

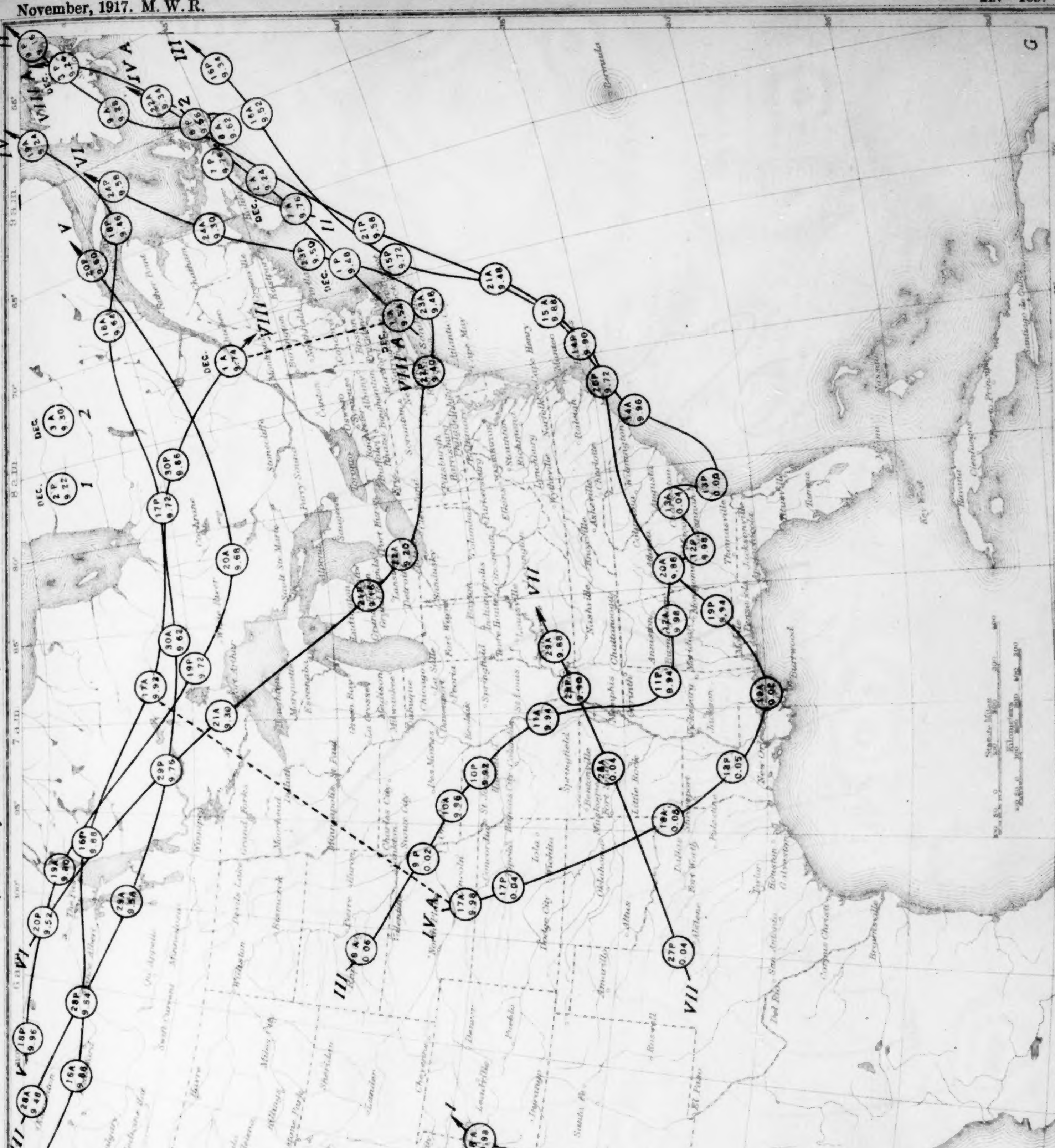


Chart III. Tracks of Centers of Low Areas, November, 1917.
(Plotted by Charles A. Donnel.)

Chart IV. Departure (°F.) of the Mean Temperature from the Normal, November, 1917.

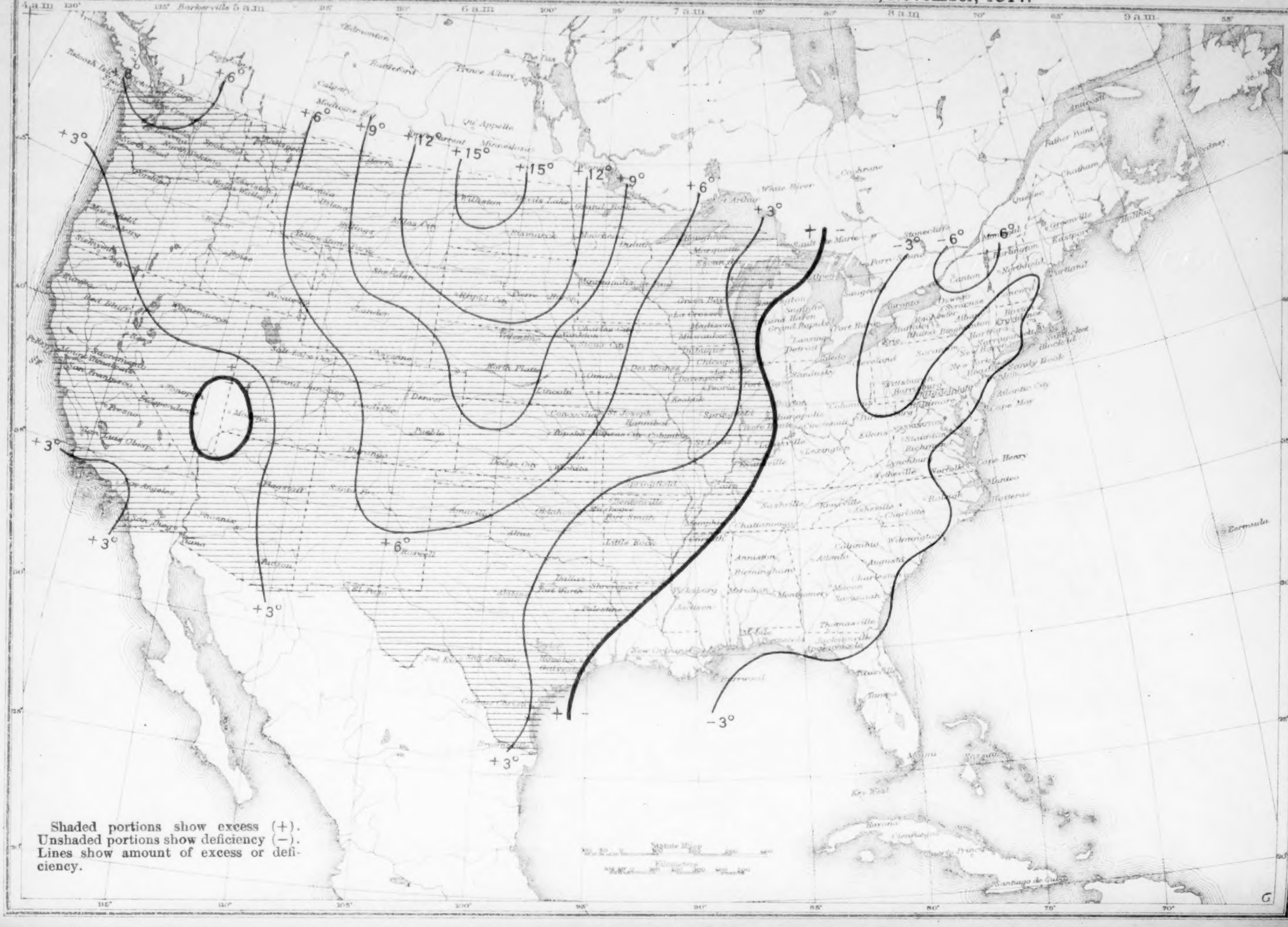
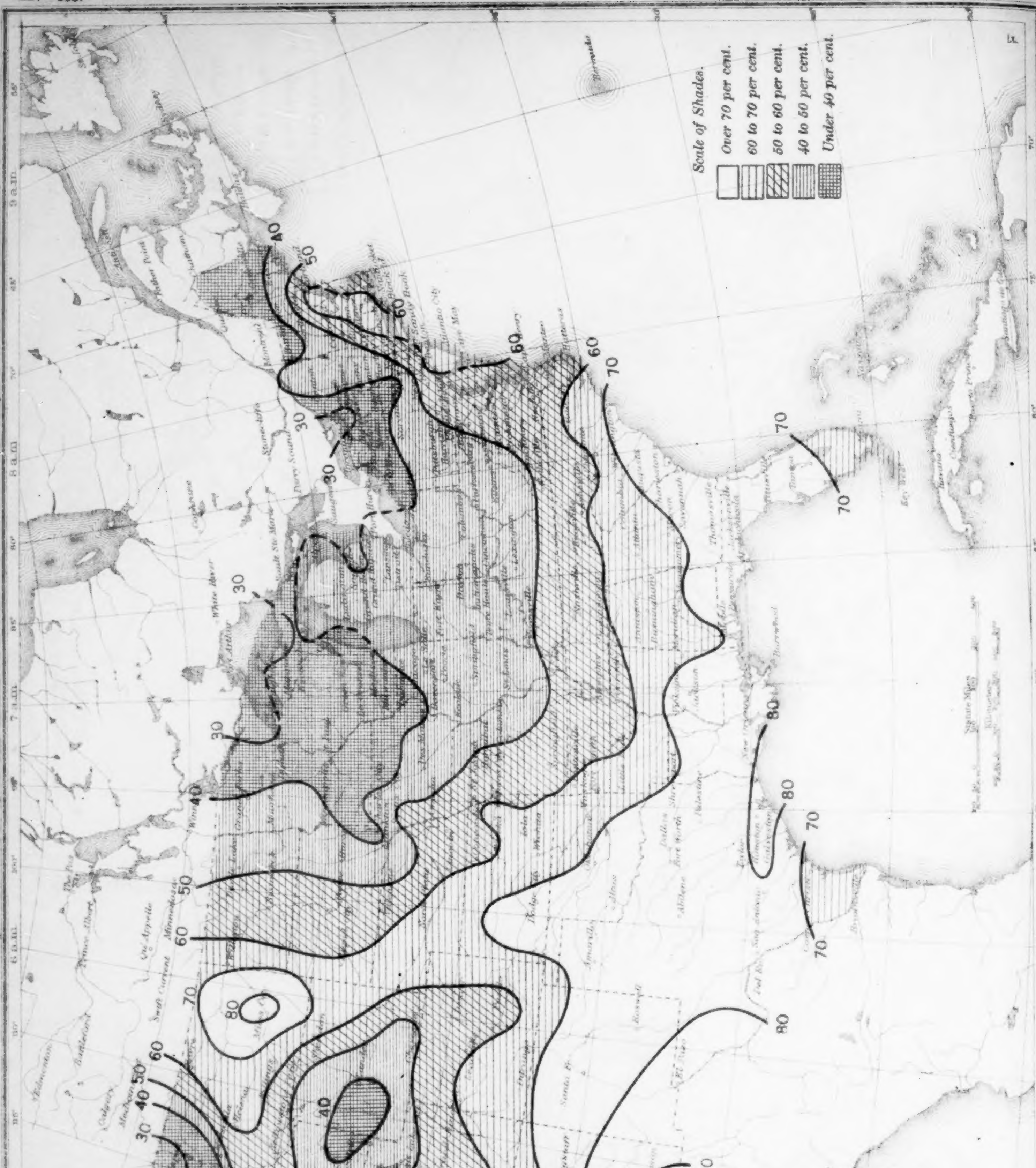


Chart V. Total Precipitation, November, 1917.

Chart VI. Percentage of Clear Sky between Sunrise and Sunset, November, 1917.



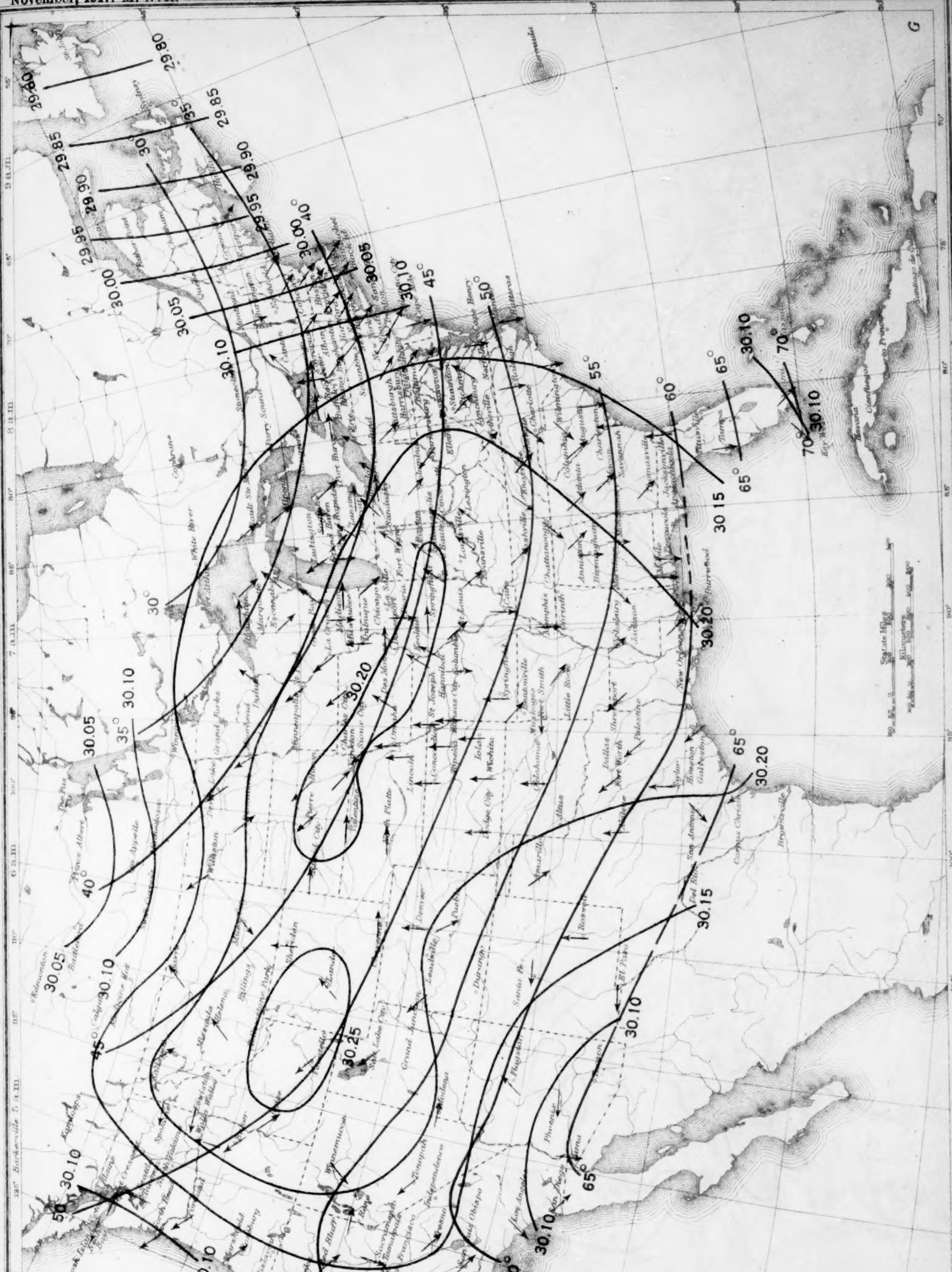


Chart VII. Isobars and Isotherms at Sea-level; Prevailing Winds, November, 1917.

Chart VIII. Total Snowfall, Inches, November, 1917.

Chart IX. Means of Meteorological Data for North Atlantic Ocean, November, 1916.

(Plotted by F. A. Young.)